SCIENCE ABSTRACTS.

Section A.—PHYSICS.

OCTOBER 1910.

GENERAL PHYSICS.

1378. *Accuracy of Stückrath Pressure Gauge.* **H. F. Wiebe.** (Zeitschr. Instrumentenk. 30. pp. 205–217, July, 1910. Communication from the Physikal. Techn. Reichsanstalt.)—Describes in detail, with sketches, the Stückrath pressure gauge, which is of the piston type. Tables are also given of the results of elaborate tests of the accuracy of the instrument up to pressures of 500 kg. per cm.^{2}. From these it appears that up to 200 kg. per cm.^{2} the reading with all the four cylinders tested was slightly too small. From 200 to 500 kg. per cm.^{2} the readings were slightly too high; but the errors are small, any particular reading being correct to at least 1 in 2000.

A. W.

1379. *Physical Units: A.E.F. Proposals.* (Deutsch. Phys. Gesell., Verh. 12. 11. pp. 476–489, June 15, 1910. Ausschuss für Einheiten und Formelgrössen.) —The 15° Calorie is $4{\cdot}189 \times 10^6$ ergs: the average Calorie from 0° to 100° C. is the same. The gas-constant $R = 8{\cdot}316 \times 10^7$ when the erg is the unit of work; 1·985 when the gramme-calorie is the unit. The international Joule is 0·23865 Calorie. The 15° Calorie is 427·2 metre-kilogrammes with gravity at 45° latitude and at sea-level. The reciprocal of resistance is "Leitwert"; its unit on the practical e.m. system is the Siemens S (instead of Mho). The reciprocal of specific resistance is "Leitfähigkeit" or "Specifischer Leitwert." *Symbols and Abbreviations.*—Length, m, km, dm; cm., mm.; $\mu = 0{\cdot}001$ mm. Surface, a, ha; m^2; km^2, dm^2, cm^2, mm^2. Volume, l, hl, dl, cl, ml; $\lambda = 0{\cdot}001$ ml; m^3, km^3, dm^3, cm^3, mm^3. Weight or mass, t, g, kg, dg, cg, mg; $\gamma = 0{\cdot}001$ mg. Period of time st, mn, sk; time of day, ^{h}, ^{min}, ^{sek}. Forces in dynes (dyn) or in grammes, &c., (g*, kg*, &c.). Work, mkg, Pferdestärkenstunde PWst or Stundenpferd Pst; watt-hours Wst, kWst; Activity, Pferdestärke or Pferd, Ps or P; Watt W; kW. Tension kg*/mm^2, kg*/cm^2. Atm. = 76 cm. Hg at 15° C.; at = 1 kg*/cm^2. Heat, °C = degree Centigrade; Ca, ca. Light; HK = Hefner candle, Lm = (Hefner-) lumen; Lx = (Hefner-) Lux. Amperes A, volts V, Ohms Θ, Siemens (= Mhos) S, Coulombs C, Joules J, Watts W, Farads F, Henries H ; Volt-coulombs VC ; Watt-hours Wst ; Volt-Amperes VA ; Ampere-hours Ast ; milliamperes mA ; kilowatts kW ; microfarads μF ; megohms *MΘ*. [See also Abstracts Nos. 412A and 649B (1910).] A. D.

1380. *Torsional Elasticity of Guttapercha.* **G. Grobe.** (Ann. d. Physik, 31. 5. pp. 971–1016, April 5, 1910. Extract of Inaug.-Dissertation, Göttingen.) —This investigation is a continuation of the work of Kautz (Inaug.-Dissertation, Göttingen, 1908), who has carried out an exhaustive research on the tension properties of the same material. The practical interest of the work lies in the fact that many instruments depend on these properties, and hence it is desirable that we should have a complete knowledge of any deviation from the laws generally assumed to hold for such material. One of the most important parts of the research was to investigate the effect of temperature and longitudinal pull on the torsional modulus. The effect of internal friction and time-effect (Nachwirkung) were also investigated. The method employed to determine the elastic properties was to measure the time of torsional vibration. Two sets of apparatus were used: in one the swinging mass was suspended below the specimen and hence the direct tension was that due to the weight of this mass; in the second, the swinging mass was above the specimen and suspended by a constantan strip, the elastic properties of which were investigated separately. By this means the tension was independent of the weight of the swinging mass. Temperatures were varied by surrounding the specimen with a water-jacket, and were measured by three thermometers; time was measured by means of a "Fuess" electric chronograph and also an ordinary stop-watch. The time of a single vibration was in general determined to ± 0·005 sec. Correction for the logarithmic decrement was made by means of a mirror attachment. Length of specimen was 848·4 mm. and the diam. 2·798 mm. or in that neighbourhood. The discussion of results is put under the following sections: (1) The determination of the torsion coefficient. This section explains the mathematical investigation by which the effect of friction was eliminated (log. decrement method). (2) Effect of moment of inertia and tension on C. An increase of K (moment of inertia) from 565·4 to 2627·8 kg. mm.^{2} caused a falling off of C from 4·687 to 4·405 kg. wt./mm^2; after this C remained practically constant. The effect of tension was small. (3) Change of C with temperature. There is a straight-line relation between these for temperatures of from 9·1 to 24·2° C., C decreasing from 4·58 to 3·10. (4) Explains the apparatus and method employed for the determination of the time-effect (Nachwirkung). This was similar to that employed by Kohlrausch, Neesen, and others, and consisted in principle in determining the difference in deflection between the top and bottom of the specimen at different periods of time. (5) Gives the results of experiments to determine the effect of duration and magnitude of initial twist on the time-effect, and also the evaluation of Kohlrausch's *Coefficient of Time-effect.* (6) Treats of the damping of torsional vibrations; (7) the dependency of same on temperature; (8) the effect of damping on the period of vibration. (9) Explains experiments for the determination of the effect of tension load on damping. A final section discusses the results in general while an extensive Appendix deals with the Wiechert theory of time-effect.

C. A. M. S.

1381. *Tests of Vanadium-Steel Bars.* (Eng. Record, 62. p. 122, July 30, 1910.)—Records tests made on two 14 × 2-in. eye-bars. Chemical composition of material was as follows: C, 0·25; V, 0·17; Ni, 1·45; Cr, 1·20; Mn, 0·32;

Si, 0·12; P, 0·02; and S, 0·085. After forging, the bars were heated to 875° C., and then hardened by means of numerous water-sprays acting simultaneously each side of bars. Hardened bars were then annealed at 720° C., to restore the material to finely crystalline structure. The value of stress at elastic limit was 70,000 lbs. for both bars. Values of yield-point were 80,900 and 81,500 lbs., and ultimate strengths were 97,100 and 96,500 lbs. per sq. in. Elongation for bar A was 28·8 per cent. in 12 in., and 7 per cent. in 21 ft.; for bar B it was 30 per cent. in 12 in., and 5·4 per cent. in 21 ft. C. A. M. S.

1382. *Electric Heating of Test-pieces and Temperature Measurements during Repetition of Stress Experiments with Pipes.* **K. Memmler** and **A. Schob.** (Königl. Materialprufüngsamt, Mitt. 28. 6. pp. 307–338, 1910.)—The machines are installed in a special department at the depôt, and are intended for the testing of wrought-iron and copper specimens of tube material under repeated stresses at 20, 100, 200, 300, 400, 500 and 600° C. The first section of the paper describes the installation. There are 20 vertical testing machines worked by water at 120 atmos. pressure. By means of valves resembling a steam-hammer mechanism and worked by electricity, the stress in the test-piece undergoes alternating variations, the number of which is counted by a mechanism worked by the same current. The machines are arranged in four rows of five, the controlling gear, pyrometers, &c., being placed on adjoining tables. As previously mentioned, the vertically arranged specimens can be heated by detachable electric furnaces, which completely surround the specimen, being made in two parts and bolted together when in place. The furnaces are of fire-clay with Pt resistances, wound on porcelain rods embedded therein. After bolting in place, asbestos wool is employed to stop up all outlets. All the leads are brought to a board where everything can be regulated. Eight furnaces can be worked simultaneously. For temperature measurement silver-constantan pyrometers are employed. Owing to the fact that it is necessary to sometimes keep these pyrometers in use seven to eight days, or occasionally considerably more, at 600° C., several curious phenomena have been noticed, due to oxidation of the elements and the fact that changes in the structure of the silver take place. In two cases small pieces of glass from the fire-clay oven became melted and cemented to the elements. On withdrawing the pyrometer after a long time at 600° C., the galvanometer continued to record 150° C. for a considerable time owing to a galvanic couple being formed. The second part discusses numerical results obtained when investigating different problems. They are set forth briefly as follows: (*a*) *To establish whether it was possible to maintain the same temperature throughout one furnace.* This seems fairly possible at temperatures below about 400° C., but at temperatures in the neighbourhood of 600° C. at the centre of the furnace there was a falling off of nearly 100° at the top and bottom. (*b*) *To determine how far the shape of the specimen affects the variation of temperature.* Three types were employed: one a plain specimen nearly filling the furnace; in the second, the centre part was turned to a small diam., while in the third type the specimen was turned down in three places to different diameters. In the first of these a temperature-difference of 30 deg. was found in different parts, reduced with the second type to about 21 deg., and with the third to 24 deg. The conditions were considerably improved by filling the empty spaces with copper turnings. Careful measurement showed a considerable difference between the temperature of the wall and the temperatures along a vertical axis of the furnace, but these latter were fairly constant. (*c*) *Comparison of temperatures measured with the electric pyrometer and with a mercury thermometer.* Diagrams and tables show different methods of placing the instruments and the results recorded. In the most favourable conditions a difference of from 7 to 12 deg. existed between the two instruments when measuring temperatures of the order of 300 to 400° C. (*d*) *Experiments to determine the relation between the temperature of the specimen as compared with that of the furnace.* With these experiments was combined a comparison of the silver-constantan couple with a Pt-Rh couple, fused into quartz glass, and fitted with water-cooling. While satisfactory work, so far as temperature-measurement is concerned, was obtained with the latter instrument, it proved too delicate for standard use. It served, however, as an excellent means of measuring the temperature of the specimen when placed in close contact with it. Experiments were performed, and are set forth in detail in the paper so as to give a close idea of: (1) how far the temperature of the furnaces could be maintained constant, and (2) the relation between the actual temperature of the specimen and the temperature as recorded by pyrometers inserted into various parts of the furnace itself. C. A. M. S.

1383. *Tests of Nickel-Steel Riveted Joints.* (Eng. Record, 62. pp. 200–205, Aug. 20, 1910.)—An official record of tests made by the Board of Engineers, Quebec Bridge. The record treats of 5 test joints for each of 18 types—of joints in 3·3 per cent. nickel steel from a single riveted lap joint up to a zigzag butt-joint for double plates with six cover-plates. These were tested in tension. There was also tested a joint for alternate tension and compression, such as might occur in wind bracing. All the experiments were carried out on a 600,000-lb. screw-power Riehlé testing-machine and were set out to correspond with the similar tests on carbon-steel joints conducted by the American Railway Engineering and Maintenance of Way Association in 1905. Of each 5 joints, 3 were hydro-pneumatic machine-driven and 2 driven with hand pneumatic hammer. Deformations were observed both by means of a specially designed extensometer and also by the movement of paper strips glued across the edges of the joint. Tested as thin plates the material used had a yield-point of 56,130 lbs. per sq. in., and an ultimate strength of 84,370 lbs. per sq. in., while the shear strength of the rivets was about 66,370 lbs. per sq. in. in single shear and 64,130 lbs. per sq. in. double shear. All the joints failed by shearing of the rivets when the shear stress was about 56,000 lbs. per sq. in., the strength of the joints being about 16 per cent. greater than for the corresponding carbon-steel joint. Complete details are set forth in the paper. In the alternate-stress tests the joint was loaded first in tension, then an equal amount in compression by placing a screw jack on the bed of the machine and forcing the top of the joint up against a fixed cross-beam. Some interesting shear-deformation cycles were obtained and are shown plotted in the original paper. The important point brought out is that, while the ultimate strength of such joints does not seem greatly effected by this alternate loading, the total movement of the joint gradually increases to a point where, if it occurred in a structure, it might change the general stress-distribution so as to have serious consequences. C. A. M. S.

1384. *Endurance of Metals under Alternating Stresses and Effect of Rate of Alternation on Endurance.* **E. M. Eden.** (Univ. of Durham Phil. Soc., Proc. 3. 5. pp. 251–257; Discussion, pp. 258–266, 1909–1910.)—After reference to the work of Wöhler the author points out that his paper is limited to inquiry as to possible effect of rate of variation of alternation on the endurance of metals. He gives results of some tests on this point made with the new repeated-load testing-machine at University College, London. The machine is of the rotating beam type, in which the test specimen is revolved while subjected to bending moment. Things are arranged so that the bending moment on the test-piece is uniform and, therefore, there is no shearing stress on it. Ball bearings are used to prevent possible heating and torsional stress. Specimens were ground to ⅜ in. diam. Five materials were tested (1) ½-in. bright drawn mild steel rod, quality A ; (2) as in 1 but quality B ; (3) ½-in. bright drawn wrought-iron rod ; (4) vanadium steel, annealed ; the same, oil tempered. Stress-revolutions curves are shown, the speed being about 300, 600, 1300 r.p.m. Within the range of the experiments the endurance is independent of speed at which machine is run. Oil-tempered vanadium steel gave irregular results. The author's figures are compared with those of Reynolds, and Smith's alternating stress tests on direct tension and compression. In these tests a very large and definite speed effect was found, and the author considers their entirely different results to be due to the form of the test. Discussing Stanton's direct compression and tension tests at 800 alternations per min. with those of Wöhler on rotating cantilevers at 60–80 r.p.m., it is suggested that the speed effect only becomes important at higher speeds than 800 alternations per min. The author states that the difficulty of obtaining identical results from a number of experiments on one testing-machine under apparently identical conditions shows that causes affecting endurance are not understood, and theories based on comparisons between endurance figures obtained by different experimenters at different times with different machines and form of test and material should be received with the greatest caution. In the *discussion*, **T. E. Stanton** wrote that the author's results are in accordance with those given by the special ring machine devised by him at the National Physical Laboratory for alternating stress tests at frequencies of 2500 per min. Stanton has also adopted a machine of the Wöhler type for tests at 2200 alternations per min., and the results check with those from the ring machine. **J. H. Smith** wrote that his results of tests for the past two and a half years convince him of the truth of his former results. **J. Morrow** said that disagreement of various experiments showed we had not got to the bottom of the subject. He was convinced that the methods ordinarily adopted for calculating bending stresses were responsible for much of mystery of all results on this work. He believed that, well within elastic limit, the well-known Euler-Bernouilli theory of bending much overestimated the stress. The **Author,** in reply, said that results of his tests do not appear to fit in with the Bauschinger theory of fatigue. Comparative endurance of different materials seems to depend both on tenacity and limit of elasticity. He did not think his speed effects could be explained by incorrectness of the ordinary beam theory. C. A. M. S.

1385. *Variation of Cubic Compressibility o, Sodium and Potassium with the Temperature.* **L. Protz.** (Ann. d. Physik, 31. 1. pp. 127–148, Dec. 30, 1909. From Dissertation, Marburg.)—The author determined the variation of the cubic compressibility of sodium and potassium with the temperature. The apparatus employed was practically that used by Röntgen and Schneider in their measurements of the compressibility of water and certain solid substances. The chief results obtained are as follows : A determination of the cubic compressibility of water, petroleum, sodium, and potassium shows that it is dependent upon the temperature to a marked degree, the rule apparently being that with rising temperature the cubic compressibility increases as a linear function. Water forms an exception, showing a more complicated variation: at 60° C. there is a minimum of cubic compressibility. As the compressibility increases with the temperature, the difference between the specific heats, $C_p - C_v$, increases also, as would be expected from the practical independence of C_v of the temperature. The deviations of the product of C_v and the atomic weight from the constant are ascribed to the influence of electrons. Comparing the electrical conductivity of the alkali metals with that of another metal, expressed for the same number of atoms, it is seen that potassium has the best electrical conductivity while that of sodium is only slightly less. It follows, therefore, that in these metals there must be a large number of free electrons (conducting electrons), or that they must be extremely mobile. Either of these alternatives will serve to explain the abnormal value obtained for the atomic heat of potassium.

F. J. B.

1386. *Mean Pressure exerted on a Body by a Variable Air-current.* **A. Lafay.** (Comptes Rendus, 151. pp. 144–146, July 11, 1910.)—The pressure distribution over the surface of a body in an air-current has been studied by means of a manometer connected to a small hole in the surface impinged upon. In the case of a well-polished cylinder, the pressure falls off from the front to the rear of the cylinder, reaching equality with that of the atmosphere about 85° from the front point; over all the surface behind this region the pressure is below that of the atmosphere: the distribution of pressure is a function of the diam. of the cylinder. It is important to observe that the defect of pressure increases more rapidly than the V^2 law demands, and that if V varies rapidly about a mean, a much greater defect of pressure will be observed than if V be constant. It is evident, therefore, that variations in V may account for discrepancies observed between experiments carried out under apparently identical conditions. The use of a microphone is suggested for the detection of variations in V. It is suggested that an irregular wind may have a greater lifting effect on an aeroplane than a regular wind of equal mean velocity. The following experimental data are quoted:—

Diameter of Cylinder.	Pitot-tube Readings.		Pressure in mm. above or below Atmospheric Pressure at different Angular Distances from front of Cylinder.									
	Pressure.	Speed.										
	mm.	m.	0°	15°	30°	40°	60°	70°	80°	100°	120°	180°
No. 1, 50 mm.	40	25	40	34	16	0	−25	−24	−21	−19	−18	−16
"	20	18	20	17	8	0	−11	−10	− 9	− 9	− 9	− 8
No. 2, 75 mm.	40	25	40	35	14	−6	−30	−45	−43	−29	−21	−17
"	20	18	20	16	7	−2	−14	−16	−15	−12	−10	− 8
No. 2, in a very irregular wind	20	(apparent) 18	20	16	6	−3	−21	−27	−29	−22	− 8	− 5

C. A. B.

1387. *Variation with Temperature of the Viscosities of the Gases of the Argon Group.* **A. O. Rankine.** (Roy. Soc., Proc. Ser. A. 84. pp. 181–192, July 28, 1910. Phys. Zeitschr. 11. pp. 745–752, Sept. 1, 1910.)—The author has determined the viscosity of the gases of the argon series at temperatures between that of the room and 100° in an apparatus similar to that previously described

[Abstract No. 888 (1910)]. The viscosities could not be determined with this apparatus at temperatures above 100° on account of the vapour pressure of mercury becoming too great to be neglected. The ratios of viscosities at the two temperatures at which determinations were made (given within brackets) are as follows: Helium (99·7°, 18·2°), 1·195; neon (100·0°, 18·8°), 1·185; argon (99·6°, 16·0°), 1·226; krypton (100·0°, 16·3°), 1·245; xenon (100·1°, 15·3°), 1·272. By comparing the times of fall of the mercury drop in the different gases with that in air, the ratio η/η_{air} was obtained as follows: Helium (18·2°), 1·085; neon (18·8°), 1·718; argon (16·0°), 1·222; krypton (16·3°), 1·362; xenon (15·3°), 1·234. Using Sutherland's formula—

$$\eta = \eta_0 \left(\frac{T}{T_0}\right)^{\frac{3}{2}} \left(\frac{C + T_0}{C + T}\right),$$

where C is a constant depending on the attraction of the molecules, the author finds for C the following values: He, 70; Ne, 56; Ar, 142; Kr, 188; Xe, 252; air, 116. Since for a perfect gas C should be zero, it follows that Ne is the most perfect gas known (C, for hydrogen, is 83). So far as Ar, Kr, and Xe are concerned, the value of C is sensibly proportioned to the critical temperature, but this does not seem to hold in the case of He. With regard to other gases, the author finds from known determinations that the above proportionality holds for nitrogen, oxygen, CO_2, ethylene, and nitrous oxide, but not for hydrogen. Finally, the absolute values of the viscosity of the rare gases, based on the absolute values for air previously determined, are as follows:—

Helium ...	18·2°	1·942 × 10^{-4}	Krypton	16·3°	2·459 × 10^{-4}
	99·7°	2·322		100·0°	3·068
Neon......	18·8°	3·080	Xenon ...	15·3°	2·222
	100·0°	3·652		100·1°	2·827
Argon ...	16·0°	2·204	Air.........	15·9°	1·803
	99·6°	2·702		99·8°	2·189

The author also calculates the relative radius, volume, and atomic density of the gaseous molecules. A. F.

1388. *Bending of the Supports of Pendulums used in the Determinations of the Value of Relative Gravity.* **G. Abetti and C. Cappello.** (Accad. Lincei, Atti, 19. pp. 109–114, Aug. 7, 1910.)—In determinations of the value of *g* made with v. Sterneck's pendulum, various methods have been used by different observers for obtaining the corrections necessary to reduce the time of vibration to what it would have been for an absolutely rigid support. Difficulties arising from the practical impossibility of obtaining a sufficiently solid piece of masonry from which to attach the pendulum support, the minute accidental and periodic movements revealed by sensitive seismographs, and other movements of the air and diurnal variations of temperature, &c., all introduce disturbing elements differently estimated. Another disadvantage essential to this method consists in the fact that the pendulum and the supporting wall are not in general at the same temperature, and the moisture as well as other atmospheric conditions are different for each. C. Chistoni intends making some observations also with a modified form of this apparatus, the v. Sterneck-Stückrath, already employed by G. Lorenzoni and C. v. Orff. A "filar" pendulum is used whose point of suspension is fixed to the upper part of the support, so that it is constrained to partake in the movement of the latter due to the motion of the "principal" pendulum (a reversible Repsold instrument), which is set oscillating for the determination of the value of g. The relation between the amplitudes of the two instruments gives a direct measure. The two pendulums are respectively called "moved" and "motor." A description is also given of a suggested form of support proposed by Haid. Formulæ for the calculation of the corrections to be applied, for the special case of the equal pendulums, to reduce the time of vibration to that for perfectly rigid supports, were given by Haid, Schumann, and others. Haid's formula and its derivatives are given in some detail in the paper. For the v. Sterneck pendulums he finds approximately, $(\pi/2)\sqrt{(1/l_1 g)} = 0{\cdot}998$, l_1 being the length of the "motor" pendulum in metres. The experiments of Haid, Schumann, and Alessio, made expressly for the purpose of increasing the flexure of the supports, are referred to, and seem to show that the value of $\sigma_1 = d_2/d_1 \,.\, \delta_1\delta_2/\pi l$, where d_1 and d_2 are the amplitudes of the "motor" and "moved" pendulums respectively, δ_1 and δ_2 their times of vibration, is sufficiently close. Haid in his measures placed the support of his pendulums on a marble plane, and thus obtained a correction to the time of oscillation of only 10–12 units in the seventh place, varying only slightly from place to place. Further details as to this method, the results obtained, and the use of Alessio's proposed direct determination of the coefficients of flexure, will be described in a future paper. F. W. H.

1389. *Molecular Frequencies.* **F. A. Lindemann.** (Phys. Zeitschr. 11. pp. 609–612, July 15, 1910.)—From the work of Einstein and others the author here calculates the frequencies proper to certain molecules, the mean discrepancy between theory and observation being 16·3 per cent., the higher values being those due to theory. The molecules dealt with are KCl, NaCl, CaF_2, SiO_2, sulphur and diamond. [See also Abstracts Nos. 439 (1907) and 942 (1910).] E. H. B.

1390. *Radius of Molecular Attraction.* **C. W. Chamberlain.** (Phys. Rev. 31. pp. 170–182, Aug., 1910.)—Several attempts have been made to determine the radius of action, R, of molecular forces, from observations on thin liquid films. Plateau considered it would be impossible for a liquid film to exist if any part were thinner than 2R. Quincke held that the tension in a liquid film becomes smaller when fewer liquid particles affect both its surfaces than in a thick liquid layer, or when there are fewer particles within a distance R from the liquid surface. This would be the case when a liquid film becomes thinner than 2R. In this case the greater tension in the thicker portions of the film would cause it to burst. The same opinion seems to be held by Johonott [see Abstract No. 1338 (1899)]. Considering the capillary layer as a gradual transition from the liquid phase to the vapour phase Bakker reaches the conclusion that a liquid film must always consist of a layer of liquid, limited by two complete capillary layers, and that the layer of liquid must have a minimum thickness equal to R. Since the thickness of the capillary layer is of the same order of magnitude, we can take R as approximately the one-third part of the minimum thickness of a liquid film [see Abstract No. 800 (1909)]. The method here used is a modification of Quincke's in which a glass plate has a wedge-shaped layer of silver ; a special form of compound interferometer was also used. The chief results obtained are as follows: (1) Johonott's determination of the limiting thickness of liquid films is found to be correct, viz : 6×10^{-7} cm., as now verified by the compound interferometer. (2) Accepting Bakker's conclusion that R is one-third this, we have $R = 2 \times 10^{-7}$ cm. (8) There is an error in Quincke's direct determination of R, due to a failure to consider all the effects of surface tension upon the free surface of a liquid included between two parallel glass plates, opposite portions of which are covered with wedge-shaped layers of silver. The correct value for R determined directly is $1{\cdot}5 \times 10^{-7}$ cm. E. H. B

1391. *Determination of Vertical Component of Air Motion.* **W. Trabert.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 1379–1397, Nov., 1909.)—Since 1908, a graphic representation of the temperature conditions over Berlin-Lindenberg up to a height of 5,000 m. has been published for each day in "Das Wetter." The method of representation is by means of isotherms shown on diagrams in which the ordinates represent height, and the abscissæ time. The author has used this material for the construction of a series of charts on which lines of equal potential temperature are shown, the co-ordinates being the same as in the original diagrams. (The potential temperature at a point in the free atmosphere is the temperature which the air there would have if it were brought adiabatically to the earth's surface.) If we assume (1) that all changes in the atmosphere take place entirely adiabatically, (2) that horizontal motion is entirely absent, then the downward slope of the lines of equal potential temperature of Trabert's diagrams gives the velocity of downward motion of the air. If air is rising the phenomena are complicated by condensation, and in this case the slope of the lines gives no clue to the magnitude of the upward motion. The first assumption, that changes take place adiabatically, corresponds approximately with the conditions actually prevailing in the free atmosphere. The effect of horizontal motion is then considered, and it is found that it can only introduce a comparatively small correction into results calculated on assumption (2). Thus we can determine the scale of magnitude of the vertical velocity from the lines of equal potential temperature, and if the value exceeds 100 m. per hour, it may be regarded as a close approximation to the truth. Vertical velocities exceeding 1000 m. per hour are very rare; they occurred in about 1 per cent. of the cases for which a downward component could be identified. The most frequent values lie between 30 and 100 m. per hour, but smaller values are also common. The highest values were not found in the centre of an anticyclone; they occurred near the margin of anticyclone in the rear of depressions. R. G. K. L.

1392. *Connection between the Pressure at the Earth's Surface and Temperature Conditions in the Free Atmosphere.* **W. Trabert.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 1591–1608, and pp. 1609–1623, Dec., 1909.)—The diagrams of the distribution of temperature for each day over Berlin-Lindenberg [see preceding Abstract] frequently show days on which the column of air over the station is conspicuously colder or warmer than on the preceding and succeeding days. Selecting arbitrarily the month of Jan., 1909, we find in it four such occasions of a warm column over Lindenberg and four occasions of a cold one. The pressure at the surface showed maxima on the days preceding the days of occurrence of each of these warm columns, the mean fall of pressure from the days of maxima to the following days being 8·3 mm.; and minima on the days preceding those of occurrence of cold air columns, the corresponding mean change from the days of minima to the following days being 5·9 mm. In other words, pressure is falling under a warm air column and rising under a cold one. In the second paper further evidence is brought forward in support of this proposition. All instances of conspicuously cold or warm air columns occurring during the six years 1903–1908 have been examined. The mean pressure for the days of cold columns, 762·5 mm., was almost the same as that for the days of warm columns, 761·7 mm. Of 317 cases of cold air columns, 260 showed a pressure minimum on one of the two preceding days, and 49 on the day of occurrence of the cold column. 217 of these cases showed a pressure maximum on one of the two following days. Again, of 272 occasions of warm air columns, 216 showed a pressure maximum on one of the two preceding days, and 39 on the day of occurrence of the warm column. 191 of these occasions showed a minimum on one of the two following days. The author then picked out from the two years 1905, 1906, the occasions of maximum and minimum pressure. Of 98 maxima, 18 coincided with the occurrence of warm air columns over the station, and 76 experienced warm columns on one of the two following days. Of 97 minima, 11 coincided with the occurrence of a cold column over the station, and 78 experienced cold columns on one of the two following days. For a typical case of transition from a barometric maximum (Jan. 4, 1909) to a minimum (Jan. 8) the author has calculated from the pressure at the surface, and the vertical distribution of temperature as given by kite ascents, the pressure at 1000, 2000, 3000, and 4000 m. At the surface pressure decreased by 31 mm. in the five days. With increasing altitude the fall of pressure increased steadily, and at 4,000 m. it amounted to as much as 38 mm. The conclusion is arrived at that cold columns are regions of descending, and warm columns regions of ascending, air currents.

R. G. K. L.

1393. *Meteorology of Peru.* **J. Hann.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 1283–1372, Nov., 1909.)—The astronomical observatory of Harvard College has established an observatory at Arequipa in Peru, in order to take advantage of the particularly favourable atmospheric conditions which prevail there. Incidentally a number of meteorological stations have become attached to the central observatory. The meteorological data for these twelve stations, of which four are mountain stations, have been published in the Annals of the Astronomical Observatory of Harvard College, vols. 39 and 49, by S. J. Bailey. In the present paper Hann discusses these results. Special interest attaches to the data from the summit of El Misti (5850 m.), as it is the highest mountain station for which meteorological data exist. Pressure is first considered. The annual variation shows a maximum in July or Aug. and minimum in Jan. or Dec. The diurnal variation is worked out, and harmonically analysed for ten stations. The first two terms are as follows :—

Mollendo, 24m., lat. 17°. On Coast : $9{\cdot}478 \sin(58{\cdot}0^\circ + x) + 0{\cdot}668 \sin(168{\cdot}6^\circ + 2x)$.

Arequipa, 2451 m., lat. 16°. Highland Valley : $0{\cdot}180 \sin(196{\cdot}8^\circ + x) + 0{\cdot}470 \sin(156{\cdot}4^\circ + 2x)$.

El Misti, 5852 m., lat. 16°. Summit of Mountain : $0{\cdot}461 \sin(226{\cdot}1^\circ + x) + 0{\cdot}294 \sin(96{\cdot}3 + 2x)$.

Santa Ana, 1036 m., lat. 12°. Valley, East of Andes : $1{\cdot}200 \sin(2{\cdot}9^\circ + x) + 1{\cdot}082 \sin(149{\cdot}2^\circ + 2x)$.

Comparisons with similar results from mountain stations in other parts of the world follow. For two stations, Arequipa and Mollendo, the data permit of the determination of the annual variation of the harmonic constants. For both stations a_2 shows a double oscillation with maxima at the time of the equinoxes and the principal minimum in June. The second section deals with results for temperature. Annual and diurnal variations are examined, and harmonically analysed whenever the data are sufficient. The ratio of the amplitude of the second order diurnal term for that of the first order term is very constant for all stations; the value ranges from 0·30 to 0·39. On El Misti the temperature rarely rises above the freezing-point; the mean temperature is $-7\cdot8°$ C. The absolute extremes are given as $-18°$ C. and $+4°$ C. Precipitation in the form of rain was not observed. Humidity, amount of cloud, precipitation and wind data are fully discussed. The anemometer records from El Misti are sufficiently numerous and trustworthy to justify the calculation of the diurnal variation. In common with mountain-peaks in Southern India, this elevated station shows a distinct double oscillation, which may be expressed harmonically as follows, in miles per hour, $12\cdot23 + 0\cdot716 \sin (188\cdot5° + x) + 0\cdot587 \sin (296\cdot8° + 2x)$. R. G. K. L.

1394. *Diurnal Oscillation of the Eiffel Tower.* **R. Bourgeois.** (Comptes Rendus, 151. pp. 466–468, Aug. 16, 1910.)—Observations show that the daily oscillation of the top (amplitude 8 to 17 cm.) is due to solar heating, the seasonal change in the direction of the movement corresponding with the different iron piers heated at different times. There is no indication of any change of the mean position during 1896–1910. A. D. R.

1395. *Measurements of Snow in the Upper Alps, and their Bearing on Variations in the Snow-line.* **J. Maurer.** (Meteorolog. Zeitschr. 27. pp. 289–301, July, 1910.)—A complete investigation of the whole matter of precipitation and the conditions prevailing in the upper regions being too costly and difficult an undertaking was not attempted by the author, but regular measures were made at selected stations, the Eiger Glacier (2330 m.), at the Bernine Hospice (2330 m.), and at Gletsch on the Rhone Glacier (1761 m.). The mean monthly rainfall is given for Säntis, where observations have been regularly made for more than 20 years, and compared with the results for the Eiger, St. Gothard, and Bernine Hospices. The total annual fall for Säntis (the mean for the period 1888–1907) was found to be 24·48 m., 72 per cent. of which fell as snow. The summit is only free from snow for about 2 months in the year (mid-July to mid-Sept.), at times when the mean temperature of the air is at or above +3° C. A table is given showing the variation of the average altitude of the snow-line and the mean temperature for 4-day intervals throughout the year, and a figure embodying these results shows the close correspondence of the snow limits with the variations in the mean depth of the snow "covering." A very remarkable temporary rise of temperature at the end of Oct. and beginning of Nov. is reflected in its effect on the curves. Further details, such as the remarkable variations in April and July, are also discussed in the paper, as well as the influence of altitude upon the times of greatest freedom from snow. For higher levels the results of some observations of Zugspitze (2964 m.) and Sonnblick (3106 m.) are given. Reference is made to the work of Forel, Muret, and Mercanton. From observations at the upper stations in the Central Alpine regions it is concluded that the average annual precipitation at the altitude of 2000 m. above sea-level is about 2000 cm., or a trifle over; the isolated summit of Naye (1970 m.), and the Rigi give somewhat smaller values. The effect of the generally damp and cold period 1836–1850 is clearly shown in its relation to the variations of the size of the glaciers. Nevertheless the relationship between these variations and the so-called

Brückner period must be a somewhat complicated one, and the materials yet to hand will scarcely enable us to get a satisfactory [approximation to] coincidence. F. W. H.

1396. *Magnitude of the Repulsive Force of the Sun.* **A. J. Orlov.** (Acad. Sci. St. Pétersbourg, Bull. 7. pp. 517–522, April 15, 1910.)—Egermann's formula for determining the magnitude of the repulsive force of the sun on the tail of a comet, besides requiring tedious calculation, often gives the indeterminate magnitude 0/0. The author's method of making this determination assumes that the motion of the molecules of a comet's tail takes place in the plane of the orbit of the comet, and the transformation from direct ascension and declination of the molecules into heliocentric co-ordinates is effected by means of the formulæ previously given (Ibid. 4. March, 1909). The calculated values are in far better agreement with the observed ones than is the case with Egermann's formula. T. H. P.

1397. *Measurement of Stellar Temperatures.* **A. Amerio.** (N. Cimento, 19. pp. 411–414, June, 1910.)—The author discusses Nordmann's method for measuring stellar temperatures [see Abstract No. 84 (1910)]. This is based on the hypothesis, which is not altogether satisfactory, that stars radiate like black bodies, and a further source of error is the impossibility of calculating the absorption exercised by the stellar atmospheres. The method is only applicable to stars belonging to groups 1 and 2 of Secchi's classification, and is less exact than that of Wilsing and Scheiner. The discrepancy between the results of Nordmann and those of other observers is probably due to the fact that the former graduated his photometer by artificial light, the temperature of which is too low. This error could be obviated by graduating the photometer by the method of Wilsing and Scheiner. The importance is pointed out of a knowledge of stellar temperatures, and thence of the distribution of heat throughout the universe, in the study of its constitution and evolution, and collaboration in such determinations by observatories throughout the world is suggested. W. H. Si.

1398. *Movements of Nucleus of Halley's Comet.* **J. C. Solá.** (Comptes Rendus, 151. pp. 869–871, Aug. 1, 1910.)—By comparison of the author's photographs with those taken in Spain by Iniguez on June 6 and 7, it is found that the velocity with which the separate condensations moved away from the nucleus was subject to a rapidly increasing acceleration. Thus on June 4 the velocity of the separate condensation was 600 metres per sec., while on June 6 it was 37,425 metres per sec. From June 4–6 the mean acceleration was 0·148 m., while from June 6–7 it was 0·248 m. This would appear to fit in with the accepted theory of solar repulsion causing the bulk of cometary streamers. C. P. B.

1399. *Occultation of η Geminorum by Venus.* **E. M. Antoniadi, F. Baldet,** and **F. Quénisset.** (Comptes Rendus, 151. pp. 866–869, Aug. 1, 1910.)—An occultation of η Geminorum by the planet Venus having been predicted for July 26, the phenomenon was carefully watched by these observers at Juvisy, each with a separate instrument. (This star varies from mag. 3·2 to 4·2 in a period of 229 days, its brightness being on that day 3·5). The sky was remarkably clear on the whole and the image of the planet fairly steady. The star very slowly and regularly decreased in brightness as the planet approached, the diminution being very rapid just before contact. In 2 or 3 seconds the star disappeared without any change in tint being perceived. The reappearance took place at the dark limb. At first a faint radiation rapidly increasing in brightness was seen, and then a more gradual recovery as the planet receded from the star. As before, no change of colour was noticed. The times of immersion and emersion were observed with an uncertainty of about a second or so, the whole phenomenon lasting 8½ min. The observed variation in brightness seems most probably explained by absorption due to an atmosphere surrounding the planet, the existence of which has been established by the phenomena at times of transit and on other occasions. The variation lasted from 1·5 to 2 seconds of time, corresponding to a displacement of 0·08″–0·11″ from the planet's surface. This corresponds to a distance of 80 to 110 km. (50 to 70 miles). Bouquet de la Grye, from his measurement of plates taken during the transit of 1882, found a height of 126 km. (80 miles) for the atmosphere of Venus. From drawings it appears that the centre of the planet passed at about 8·5″ to the south of the star, and it may be concluded that the deviation of the luminous rays cannot have exceeded 0·3″. The result seems to show that the star was only seen through the upper part of the atmosphere of Venus, the lower regions being probably too absorbent or cloud-laden. F. W. H

REFERENCES.

1400. *Physical Quantities Classified in Terms of their Dimensions.* **C. Hering.** (Frank. Inst., Journ. 170. pp. 194–205, Sept., 1910.)—The formulæ for the dimensions of physical quantities are generally classified according to their subjects. The author classifies them in groups. For instance, the first group is classified according to the powers of L it contains, and then M, T, μ, K, Θ, a are given, where Θ is temperature and a is a plane angle. A. R.

1401. *Investigation of Nature of Cracks in Glassware.* **L. Gabelli.** (Phys. Zeitschr. 11. pp. 117–123, Feb. 15, and pp. 193–201, March 1, 1910. From the Italian.)—The author attempts a classification of the different types of fracture. For the conclusions and the illustrations of the different fracture-patterns the original must be consulted. L. H. W.

1402. *Physical Properties of Building-stones.* **M. Gary.** (Königl. Materialprüfungsamt, Mitt. 28. pp. 181–211, 1910.)—The results of a lengthy investigation are set forth almost entirely in tabular form, the density, hygroscopicity, strength in compression, loss in weight when exposed to sand blast, and loss on grinding being given for each stone. The losses due to weathering are also shown. L. H. W.

1403. *Kinematics of the Rigid Body on the Relativity Principle.* **M. Born.** (Gesell. Wiss. Göttingen, Nachr., Math. Phys. Klasse, 2. pp. 161–179, 1910.)—A mathematical treatment of the kinematics on the relativity principle of a body answering to a new definition of rigidity formulated by the author. [See also Abstracts Nos. 1723 (1909), 344, 791 (1910).] E. H. B.

1404. *Elementary Theory of the Gyroscope.* **E. H. Barton.** (Engineering, 89. p. 797, June 24, 1910.)—The action of Brennan's monorail vehicle [see Abstract No. 943B (1907)] is explained.

1405. *Torsional Vibrations of Massive Loaded Shafts.* **J. T. Dixon.** (Univ. of Durham Phil. Soc., Proc. 3. 5. pp. 287–291, 1909–1910.)—Mathematical: an extension to loaded shafts of the method used for unloaded shafts. L. H. W.

1406. *National Physical Laboratory: Report for the Year* 1909. (Electrician, 64. pp. 974–976, March 25, and pp. 1015–1017, April 1, 1910. Abstract. Engineering, 89. pp. 385–387, March 25, and pp. 437–441, April 8, 1910.)

1407. *Automatic Toepler Pump for collecting the Gas from the Apparatus being exhausted.* **B. D. Steele.** (Phil. Mag. 19. pp. 863–868, June, 1910.)—Illustrated.

1408. *Determination of Position in Balloons.* **O. Voigt.** (Phys. Zeitschr. 11. pp. 674–676, Aug. 1, 1910.)—Describes with diagrams an apparatus by means of which persons in a balloon may locate their position, after determining the elevation of some known star. The paper does not admit of a brief Abstract. A. W.

1409. *Results of the Ascent of Ballon-Sondes in Russia.* **M. M. Rykačev.** (Acad. Sci. St. Pétersbourg, Bull. 7. pp. 523–546, April 15, 1910.)—The results obtained from ascents in three different parts of Russia are compared. The paper consists largely of the numerical results and of curves expressing them. T. H. P.

1410. *Chromospheric Network.* **W. Krebs.** (Phys. Zeitschr. 11. pp. 645–648, July 15, 1910.)—A description is given of notable network forms of the faculæ observed visually at the solar limb, and possible connection with a series of spot disturbances of the previous solar rotation. C. P. B.

1411. *Inequalities of Lunar Longitude.* **Schulhof.** (Comptes Rendus, 151. pp. 190–192, July 18, 1910.)—A short account is given of the derivation of the new arrangement of terms in the moon's longitude tables recently published in the Bulletin Astronomique. C. P. B.

1412. *Topography and Constitution of the Planet Mars.* **G. V. Schiaparelli.** (Accad. Lincei, Mem. 8. 2. pp. 101–156, 1910.)—A lengthy monograph dealing with the observations made at Milan during the opposition of 1890, illustrated with maps and photographic reproductions of the original drawings. L. H. W.

1413. *Formation of Saturn's Ring System.* **P. Lowell.** (Astronom. Nachr. No. 4403. Nature, 83. p. 291, May 5, 1910. Abstract.)—Discussion of causes which have contributed to form the present configuration of the ring system of Saturn. Taking comparisons between the periods of various sections of the ring and the satellites, it is suggested that Mimas has been chiefly instrumental in the formation of the rings, and in a less degree Enceladus and Tethys. C. P. B.

1414. *Fontenelle's Theory of Comet Constitution.* **W. de Fonvielle.** (Comptes Rendus, 150. pp. 849–851, April 4, 1910.)—Discussion of the theory elaborated by Fontenelle, who ascribed the phenomena of comets' tails to a similar action to that produced by light passing through a lens and afterwards falling on some attenuated reflecting medium. The phenomena of curvature are explained by introducing the effect of the velocity of light. C. P. B.

1415. *Absorption of Starlight in Relation to Milky Way.* **G. C. Comstock.** (Astrophys. Journ. 31. pp. 270–273, April, 1910.)—The paper is practically a discussion of Kapteyn's article on "The Absorption of Light in Space" [see Abstract No. 236 (1910)], suggesting that the conclusions therein may be greatly modified by a more systematic arrangement of the proper motions. This is given in tabular form, indicating an excess of absorption in the regions away from the Milky Way.
C. P. B.

LIGHT.

1416. *Pressure of Light.* **J. H. Poynting.** (Soc. Franç. Phys., Bull. 1. pp. 5–19, 1910. Journ. de Physique, 9. pp. 657–671, Aug., 1910.)—After an excellent *résumé* of the earlier work on the subject, including some recent experiments on the pressure of incident light [see Abstracts Nos. 1471 (1904), 1248 (1905), and 126 (1906)], the author concludes with an account of his experiment establishing the back-pressure of light on the surface from which it issues [Bakerian Lecture, see next Abstract]. It is shown that a disc, perfectly black on one side and perfectly reflecting on the other, if receiving radiation P on the black side and in the steady state, will experience a pressure of $\frac{5}{3}$P, viz., P due to the incident radiation and $\frac{2}{3}$P due to the equal issuing radiation distributed in all directions. Similarly for a disc black on both sides the pressure would be P only. Lastly for a disc, bright on both sides, or bright on the side receiving radiation and black on the other, the pressure would be 2P. These various cases were tested on a suitable frame suspended in a vacuum maintained by Dewar's charcoal and liquid-air method. The results as to deflections calculated and observed are as follows :—

Deflections.	Black-Black.	Black-Bright.	Bright-Bright.	Bright-Black.
Calculated	14·3	22·0	26·5	26·1
Observed	16·1	22·8	28·7	28·0

But for the disturbance of the residual gas it is believed the calculated values would have been found from the experiments also. E. H. B.

1417. *Recoil from Light.* **J. H. Poynting** and **G. Barlow.** (Roy. Soc., Proc. Ser. A. 84. pp. 534–546, May 11, 1910. Bakerian Lecture.)—All previous experiments on the pressure of radiation were made on the force exerted by light or radiation on a receiving surface. That here described shows the pressure of radiation against the source from which it starts, and from analogy with a gun is here termed the *recoil* from light. The plan and results of this work are given at the end of the preceding Abstract, but the present paper should be referred to in the original for the elaborate details of the research. E. H. B.

1418. *Interferometer with Inverse Beams of Light Superposed.* **G. Sagnac.** (Comptes Rendus, 150. pp. 1676–1679, June 20, 1910.)—Two exactly similar isosceles prisms of the same glass with their refracting angles greater than 90° are mounted with their largest faces in contact with one another. A parallel beam of light falls normally upon one of the faces of the rhomb, and on reaching the junction of the two faces is divided into two, part being transmitted, and part reflected. The transmitted portion on passing out of the rhomb is reflected from two mirrors and directed back into the rhomb along the path of the reflected portion, while the reflected portion follows the same path in the inverse direction and also falls on the junction between the two faces. The combined beam escaping through the fourth face of the rhomb is examined with a telescope. [See also Abstract No. 1106 (1910).]

E. C. C. B.

1419. *Reflecting Power of Ice in the Extreme Infra-red Spectrum.* **A. Trowbridge and B. J. Spence.** (Phys. Rev. 31. pp. 61–67, July, 1910.)—The dispersion of water has been determined in the ultra-violet by Simon, in the visible spectrum by Flatow, and in the nearer infra-red by Rubens. The constants of the dispersion formula of the Sellmeier type have been determined by Flatow, and the large value of one constant indicates strong absorption in the remote infra-red spectrum. If it be assumed that there is a single absorption band in the infra-red, it should occur at wave-length 76 μ. The authors have investigated the question by the method of *Reststrahlen,* by allowing successive reflections to take place at polished ice-surfaces, which, together with the source of light and bolometric apparatus, were kept in a room whose temperature was maintained at −22° C. Ice surfaces were used instead of water, inasmuch as the presence of water-vapour over water surfaces would give inconclusive results. A parallel beam of rays, furnished by an arc light placed at the focus of a concave mirror, was reflected successively from three large plane surfaces of polished ice, and a second concave mirror, which could be rotated about a vertical axis, brought to focus on the bolometer strip the residual radiation reflected by the three ice surfaces. A shutter between the arc and the first concave mirror permitted the beam to be shut off at will. The sensitiveness of the apparatus was tested by substituting for the ice surfaces three polished surfaces of fused potassium bromide—a substance Rubens and Hollnagel have shown to reflect selectively energy of wave-length 82·8 μ. As a brief summary of the experiment, it may be said that ice shows no region of metallic reflection in the infra-red spectrum in the interval from $\lambda = 45\,\mu$ to 82·8 μ. This probably can be said of water, yet in the present state of uncertainty as to the true value of the dielectric constant of ice (values as low as 2, and as high as 90, have been quoted by experimenters), it is impossible to state as to the validity of the dispersion formula as applied to ice, and it is likewise impossible to draw trustworthy conclusions from the optical properties of ice and apply them to water. Though the optical properties of ice and water appear to be almost identical, yet they do not seem to be identical as regards their dielectric constant. During the progress of this investigation Rubens and Hollnagel have published a paper [Abstract No. 552 (1910)] reporting the isolation of two new regions of *Reststrahlen.* From the behaviour of water towards these new radiations whose wave-lengths are greater than 76 μ, they conclude that water does not show selective reflection in the region predicted by the dispersion formulæ.

A. E.

1420. *Kerr's Phenomenon in Glasses, and Determination of the Kerr Constant for Carbon Disulphide.* **O. D. Tauern.** (Ann. d. Physik, 32. 5. pp. 1064–1084, July 8, 1910.)—The glasses experimented upon were heavy flints from Schott's works at Jena, previous examination of many ordinary commercial glasses having yielded no measurable effects. The following are the chief results: (1) The experiments confirm the fact, first observed by Kerr himself, that the Kerr phenomenon occurs in glasses in a homogeneous electric field as well as in a non-homogeneous field, and in a manner entirely analogous to what occurs in the case of fluids. (2) The Kerr constant increases with the amount of lead in the glass. (3) The Kerr constant of carbon disulphide for sodium light is $30{\cdot}42 \times 10^{-8}$, which agrees well with Quincke's values. (4) The double-refraction due to Kerr's phenomenon depends to a great extent upon the wave-length. In the c.g.s. system the Kerr constant may be defined as the difference of the refractive indices of rays polarised parallel and perpendicular, respectively, to the direction of the field, for unit fall of potential. (5) The Kerr phenomenon can be used with advantage in determinations of large potential differences. In measuring the (positive) double-refraction due to Kerr's phenomenon, the effect of negative mechanical double-refraction due to mutual attraction of the metal electrode coatings on the glass surfaces, was found to be by no means negligible. In some instances it completely masked the Kerr-effect. A. E.

1421. *Methods of increasing the Double Refraction of Bravais' Iron Solution of Recent Preparation.* **L. Tieri.** (Accad. Lincei, Atti, 19. pp. 49–53, July 17, 1910.)—The utility of the method of O. M. Corbino [see Abstract No. 1148 (1910)] of studying strong magnetic fields by means of the doubly refracting properties of Bravais' iron solution depends for its sensitiveness upon the high double refraction of the solution when old. Owing to the difficulty of obtaining solution sufficiently old, the author describes several methods of artificially "ageing" a solution of recent preparation. Several vessels of the solution prepared before 1900 are treated in different ways. One of these vessels is wrapped in black paper and exposed to the sun's rays, while the others are placed under water and exposed to sunlight. After various exposures the amount of double refraction in known magnetic fields is found and expressed in terms of difference of path, in wave-lengths, for red light. For solution prepared before 1881 the double refraction for a field of 10,000 units is negative and amounts to 8·5 λ. The greatest effect is found to be produced by exposure to sunlight. It was found that for 3 days the double refraction of the upper layers of the solution continually increased, but in 5 days it had practically disappeared. In the case of the lower layers, the double refraction increased rapidly for a day; for longer periods an inversion of the effect occurred, the sign of the effect being changed. For solution of recent preparation the double refraction continually increased, but after 5 days the liquid became too turbid and viscous to study the double refraction without diluting the solution. After 3 days' exposure the solution becomes as magneto-optically active as the old solution. The addition of hydrochloric, sulphuric, and nitric acids, drop by drop, was also found to increase the magneto-optic properties. S. G. S.

1422. *Kinematography of Living Microbes by aid of the Ultramicroscope.* **J. Comandon.** (Comptes Rendus, 149. pp. 938–941, Nov. 22, 1909. Bull. Soc. d'Encouragement, 113. pp. 318–328, March, 1910.)—The author has succeeded in obtaining kinematograph images not only of microbes in motion, but even of ultramicroscopic particles such as the granulations of the blood known as hæmokonies. The source of light was an arc of 30 amps., the rays from which were focussed so that an image of the positive crater was thrown on the diaphragm of the microscope condenser, which was a paraboloid (Siedentopf). The kinematograph arrangement was that of Pathé, specially altered for the purpose, arrangements being made that the living subjects are not subjected to the light and heat of the arc except at the moment of exposure. To give the proper appearance of movement such as is seen through the ultramicroscope, the film-views are taken at the normal rate, that is, 16 per sec., making an exposure of $\frac{1}{16}$ sec. The best results were obtained with a magnification of 280 diams. The counting of such ultramicroscopic particles as the hæmokonies has hitherto been found impossible owing to their rapid Brownian movements, but their number can be readily estimated from the film-images obtained in this way. The importance of the method is pointed out, and several photographic reproductions of blood samples containing spirochæta, trypanosomes, &c., are given to show its capabilities. L. H. W.

1423. *Electric and Magnetic Double Refraction.* **P. Langevin.** (Comptes Rendus, 151. pp. 475–478, Aug. 16, 1910.)—Using a method of calculation similar to that employed in explaining the properties of paramagnetic bodies [Abstract No. 1449 (1905)], the author shows that the phenomena of electric and magnetic double refraction of liquids can be quantitatively accounted for on the assumption that the field has an orienting effect on the molecules of the liquid [see Abstracts Nos. 1508, 2059 (1907), 809, 898 (1910)]. Magnetic rotatory power and magnetic double refraction are due to different causes: the former is due to the action of a magnetic field on the moving electrons in the molecule, whereas the latter is due to a rearrangement of the orientation of the molecular axes. The author's theory also explains the fact that the magnetic rotation is independent of the temperature, whereas the magnetic double refraction decreases rapidly with rise in temperature. T. S. P.

1424. *Action of Ultra-violet Light on Gelatine.* **A. Tian.** (Comptes Rendus, 151. pp. 219–220, July 18, 1910.)—The light from a mercury lamp has no coagulating action on commercially pure gelatine or its solutions. A gelatine jelly, however, tends to become liquid, and the liquid portion can be washed away with water, so that a picture can be obtained in relief by allowing the light to fall on a gelatine film over which a stream of water is flowing. E. C. C. B.

1425. *Radiation Laws of Metals.* **W. W. Coblentz.** (Electrical World, 56. pp. 886–887, Aug. 18, 1910.)—In connection with his recent paper [see Abstract No. 1225 (1910)] and some of E. P. Hyde's results, the author points out the danger of making deductions from premises which are only approximately true. For metals the physical facts are: (1) An extraordinary variation in their reflectivity from the visible to about 2 μ. Beyond this value the reflectivity increases slowly with wave-length. (2) A small temperature-coefficient of emissivity from the visible to 8 μ. Beyond this point the temperature-coefficient increases rapidly with wave-length. (3) For the black body the position of max. emission in the spectral energy-curve shifts, with rise of temperature, toward the wave-lengths because $\lambda_{\text{max.}}T = \text{const.}$ We also have $E_{\text{max.}} = BT^{\alpha}$. Hyde's experiments indicate that α is constant, but the author found it variable. The reason of this discrepancy is that Hyde worked in a very limited region of the visible spectrum, whilst the author worked in the infra-red where λ_1 and $\lambda_{\text{max.}}$ are far apart. A. R.

1426. *Magnetic Rotation in Crystalline Liquids.* **G. Vieth.** (Phys. Zeitschr. 11. pp. 526–527, June 15, 1910.)—The substance investigated, namely, the active amyl anisylideneamino-α-methylcinnamate, was supplied by Vorländer of Halle. Green and yellow rays were used, the fields varying from

5000 to 18,000 gauss and used direct and reversed. In the case of each kind of rays and each sense of the field, the rotation of the plane of polarisation in degrees per mm. of thickness of the active substance per gauss was practically a constant. But the rotation changed with the colour of the light and the sense of the field, the order from less to greater being (1) yellow light in left-handed rotation, (2) green light in the same, (3) yellow light in right-handed rotation, (4) green in the same. **E. H. B.**

1427. *A Method for measuring Ellipticity and the Determination of Optical Constants of Metals.* **A. Q. Tool.** (Phys. Rev. 31. pp. 1–25, July, 1910.)—An instrument which combines the Stokes and the half-shade principles for measuring ellipticity has been successfully used. Its principle consists in compensating the light down to a definite small ellipticity as tested by the Brace half-shade, instead of to plane-polarised light. The apparatus is designed after that of Stokes, the compensator being mounted on a circle movable with respect to a fixed vernier, and the analysing nicol on a second vernier movable with respect to the compensator circle. The following modifications, however, are introduced: The analyser consists of a Jellett split nicol combined with an elliptic half-shade fixed relatively to the nicol and just before it (toward the light source). This half-shade has its dividing line preferably at about 45° to its principal axis, so that when mounted with its dividing line perpendicular to that of the nicol, its optic axis will be at 45° to that of the nicol. A simultaneous "match" of the four parts of the field thus obtained constitutes a "setting." The ocular should focus on both dividing lines at the same time. Tuckerman has given the theory of this instrument [Univ. of Nebraska Studies, vol. 9, No. 2, 1909]. It has been found that it will measure the order of thin doubly refracting plates, such as are used in the Brace elliptic analyser, to 0·01°, which is an error of less than 1 per cent. for the thinnest half-shade so far advantageously employed. It will also calibrate a quarter-wave plate to 0·05°, an accuracy of about 0·05 per cent.; or it will measure an ellipticity of 0·02 to 1 per cent., and a unit ellipticity to 0·05 per cent. The introduction of the elliptic half-shade enables it further to measure circularly polarised light—where Stokes' analyser fails. This method has been applied to the investigation of the optical constants of metals by reflection, and determinations have been made throughout the visible spectrum. The max. sensibility was not attempted, since the variation arising from surface conditions rendered such accuracy useless. It appears that the value of the metallic constants cannot be determined with closer accuracy than 2 or 3 per cent. But the form of the dispersion curve seems to depend much less upon surface conditions, and hence to be more reliable. With all the metals studied observations were taken at sufficiently close intervals to determine the direction of the dispersion curve. This dispersion is found to agree in general with that of other investigators, though the magnitude of the constants chosen as representative is often different. Of especial interest are the results for copper and gold, showing the characteristics of a transmission band in the visible spectrum, the existence of which for copper has already been shown by Minor. The dispersion curves for gold show the band with its centre about 490 $\mu\mu$. In form the curves are much like those of copper, in which the band is at about 560 $\mu\mu$. Surface films, and impurities picked up during the polishing process, are the chief sources of error in obtaining the optical constants by reflection. The best results were obtained by first making the surface as smooth and plane as possible with a fine clean file, then finally grinding with very fine emery dusted over soft, dry paper laid on a plane glass. The mirror was then polished with rouge on kid, or with kid alone for the softer metals. The films formed during polishing appear generally to increase the value of all the constants. The type of film formed when the surface is exposed to air has, however, usually the opposite effect. Such films were formed in a short time, even in an hour in a very dry atmosphere. Gold and nickel were least affected. The effect of these films, if they are very thin and have not attacked the surface, is small. A matt surface, or incomplete polish, also reduces the value of the constants. A granular structure causes considerable error, which is revealed by changing the angle of incidence. A. E.

1428. *Magnetic and Doppler Spectra of Canal Rays.* **O. Reichenheim.** (Zeitschr. Elektrochem. 16. pp. 583–585; Discussion, pp. 585–586, Aug. 1, 1910. Paper read before the Deutsch. Bunsen-Gesell., Giessen, May, 1910. Phys. Zeitschr. 11. pp. 782–784, Aug. 15, 1910.)—This paper is based upon researches carried out by the author in conjunction with E. Gehrcke. W. Wien and J. J. Thomson have found evidence of the presence in canal rays in hydrogen of two kinds of positively charged ions, for one of which e/m is 10^4 and for the other 5×10^3. Thomson concludes from this that the first kind consists of hydrogen atoms and the second of hydrogen molecules. In helium a third kind of ion has been observed, for which e/m is $2{\cdot}5 \times 10^3$, and this may be looked upon as a helium atom carrying a unit charge. Ions of other gases, such as oxygen and nitrogen, are apparently not easy to observe. By means of a suitably constructed tube and a magnetic field it is now shown that three distinct kinds of ions are present when oxygen and water-vapour are in the tube, although only two kinds are observed in hydrogen, helium, and argon. Assuming an equal charge on each kind of positive ion, then it is shown that the three kinds of ions present are probably the hydrogen atom, the hydrogen molecule, and the oxygen atom. The intensity ratio of the fluorescent spots due to these ions undergoes changes when the pressure and conditions of discharge are altered. In general the spot corresponding to rays due to the hydrogen atoms is the clearest, but sometimes, especially in pure hydrogen at low pressures, the spot due to the hydrogen molecules may become as clear or even clearer than that due to the atom rays. When the tube has been recently filled with moist air the spot, which is probably due to oxygen atom rays, has the greatest intensity; this intensity always diminishes with the time, and after repeatedly filling the tube with pure hydrogen for an hour, it completely disappears. Another kind of spot is also occasionally observed for which the magnetic deflection is about one-third that for the spot ascribed to the oxygen atom rays. In helium the observations made confirm those of J. J. Thomson. In argon and nitrogen both kinds of hydrogen spots are observed, but it is not certain whether any due to argon or nitrogen exist. The researches of Stark and Steubing, and the more recent ones of Strasser, are in accord with the explanation here given to bring the present observations in line with those in which the Doppler-effect has been observed in canal rays. The following points are discussed: Are the particles which constitute the canal rays identical with ions obtained in electrolysis? Are these particles in a neutral or positively charged condition at the instant of giving out light? A. E. G.

1429. *Magnetic Separation of Absorption Lines.* **P. Zeeman** and **B. Winawer.** (Konink. Akad. Wetensch. Amsterdam, Proc. 13. pp. 35–44, June 28, and pp. 162–171, Sept. 1, 1910.)—In former papers [Abstract No. 911

(1910)] the authors have investigated the magnetic separations of absorption lines with fields between the directions 90° and 89°; they now complete the work by giving details for the remaining directions from 89° to 0°. The work is particularly applicable to the interpretation of the lines specially affected in sun-spot spectra, and in this latter portion it was thought possible to find the conditions at the special angle described by Lorentz as separating the regions of the longitudinal and transverse magnetic effect. A half wave-length plate with one of its principal directions placed horizontally and limited by a horizontal line is placed near the source of light. Vibrations from the source, making a definite angle with the edge of the plate, after traversing it are rotated through twice that angle. An image of this edge is focussed on the slit of the spectroscope, and a nicol prism interposed close to the slit. The plate covers only half of the field of view. The magnetically separated components are then seen unequally dark in the two halves of the field of view. C. P. B.

1430. *New Method for differentiating between overlapping Orders when Mapping Grating Spectra.* **A. D. Ross.** (Roy. Soc. Edinburgh, Proc. 30. pp. 448–456, 1909–1910.)—The usual method, by taking several photographs with different absorbing solutions, for differentiating between the overlapping orders is cumbersome and exceedingly expensive when very rare elements are in question. In an investigation of the spectra of certain rare earths the author made use of the different distribution of intensities among the components of the lines when resolved in the magnetic field. The components are plane-polarised, and it is known that when the plane of polarisation is parallel to the lines of the grating the intensity is a maximum. Hence if a suitable quartz lens is used in front of the grating slit it is perfectly possible from the appearance of the magnetically resolved lines to assign any line in a photograph to its order. E. C. C. B.

1431. *Reversal of Spectral Lines.* **H. Konen.** (Phys. Zeitschr. 11. pp. 663–666, Aug. 1, 1910.)—On repetition of Pflüger's absorption experiment on glowing hydrogen, R. Ladenburg with stronger dispersion observed certain reversal phenomena which he interpreted as indicating that inside the line under examination the quotient E/A, emission by absorption, is not constant. The present paper is occupied with a discussion, chiefly mathematical, of the points thus raised. [See also Abstracts Nos. 56, 1776 (1908), and 551, 909 (1910).] E. H. B.

1432. *Spectroscopic Examination of the Electric Arc.* **L. Puccianti.** (N. Cimento, 19. pp. 397–410, June, 1910.)—The author has continued his investigations on this subject [Abstract No. 2036 (1907)], taking spectrophotographs of the arcs obtained with carbon electrodes impregnated with Na, Ba, Sr, Cu, and Ag. The results confirm his previous work, and he concludes that the spectra of the various parts of an arc are very different, and that the form of the electric arc can only be stated when the radiations producing the image have been determined. The region of the sodium spectrum giving the D ray is cortical, and the hollows in the images obtained with sodium light are also observed with the 614, 554, and 455 lines of Ba and the 460·8 line of Sr, showing that these are lines of low excitation, whereas the 418 Ba line and the spectra of Cu and Ag have little or no hollow core, indicating a state of high excitation. [See also Abstracts Nos. 583 (1904) and 664 (1908).] W. H. St.

1433. *Duration of the Emission of Spectral Rays by Luminous Vapours in the Electric Spark.* **G. A. Hemsalech.** (Comptes Rendus, 150. pp. 1743–1745, June 27, 1910.)—A measurement of the length of duration of a number of rays of Fe in the spark. The method employed was to pass a constant blast of air through the spark, the slit of the spectroscope being set parallel to the air-current. In general it was found that the duration is proportional to the intensity of the rays, though exceptions were noted; the duration generally increases with increase of capacity. E. C. C. B.

1434. *Position of the Ultimate Rays in the Spectral Series.* **A. de Gramont.** (Comptes Rendus, 151. pp. 308–311, July 25, 1910.)—In the case of the alkali metals the ultimate rays belong to the principal series and are the following: Li 6708, Na 5896 and 5890, K 4047 and 4044, Rb 4216 and 4202, Cs 4593 and 4555. In the case of Mg, Ca, Sr, Ba, Cu, and Ag the well-known doublets now attributed to the yet undiscovered principal series form the ultimate rays. The ultimate rays Al 3961 and 3944, In 4511 and 4102, Tl 5350 and 3776 belong to the second subordinate series, but, as Rydberg has noted, these pairs bear a direct but inversed relation to a principal series—a fact which Runge confirms from their behaviour in the magnetic field. In the case of the second type of regularity noted by Kayser and Runge, it is noteworthy that none of the lines falling into these regularities belong to the group of ultimate rays. This concerns the elements Sn, Pb, Bi, As, and Sb. E. C. C. B.

1435. *Investigation of the Long-wave Region of the Nitrogen Band Spectrum.* **R. v. der Helm.** (Zeitschr. wiss. Phot. 8. pp. 405–432, July, 1910.)—A measurement with a grating of the heads of the bands of the spectrum of nitrogen between the limits $\lambda = 6874$ and $\lambda = 5188$. The second law of Deslandres is proved to hold good. Some measurements with a larger grating were made of the component lines of the bands between $\lambda = 6623$ and $\lambda = 6546$, but an attempt to arrange these in series failed. E. C. C. B.

1436. *Secondary Homogeneous Röntgen Radiation.* **J. C. Chapman and S. H. Piper.** (Phil. Mag. 19. pp. 897–903, June, 1910.)—In addition to the secondary Röntgen radiations another type of radiation is emitted, consisting of negatively charged particles identical with those found in a vacuum tube. There are several objections to the hypothesis that the homogeneous X-radiation may be due to the sudden alteration in velocity of an ejected electron, or to the subsequent bombardment of other atoms by the ejected electron. The chief argument against this is that the secondary radiation is of constant penetrating power and perfectly homogeneous. An experiment was made to determine whether an appreciable part of the homogeneous secondary radiation from an element is due to the subsequent bombardment of atoms by the electrons liberated by the primary pulses. A primary beam of X-rays of a degree of hardness sufficient to excite homogeneous copper radiation without directly stimulating the homogeneous silver rays, was allowed to fall on an alloy plate consisting of two parts of Ag to one of Cu, and the resultant secondary beam was received by two electroscopes, one of which was used to test the penetrating power of the beam while the other served to standardise the intensity. Since the Cu radiation was excited, corpuscular radiation accompanied it, and the object of the experiment was to see if these electrons ejected from the Cu on bombarding the Ag atoms made them give off their characteristic secondary radiation. If this had happened the Ag radiation would have been superimposed on the Cu, and the difference between the absorption coefficients by Al of the Cu and Ag radiations in this composite beam would have enabled each to be distinguished. If, on the other hand, this effect was small or possibly non-existent, the radiation from the alloy would have corresponded to that from a pure Cu plate. When the radiation from the alloy was allowed to pass into the electroscope without previously passing through any absorbing plates, the percentage absorption of the beam by a thin sheet of Al placed in the path of the rays was found not to differ from that of a beam from a pure Cu plate; examined in this way the radiation from the alloy was indistinguishable from a homogeneous Cu radiation. In order, however, to magnify the effect which would have been given by any Ag radiation in the rays from the alloy, the beam was allowed to pass, before being analysed, through a thickness of Al which absorbed 70 per cent. of the incident Cu radiation, while this thickness only cut down the much more penetrating homogeneous radiation from a silver plate by 7 per cent. On testing the radiation coming through this thickness, its penetrating power was found to differ only slightly from that of homogeneous radiation. This experiment showed that the electrons leaving the Cu and bombarding the Ag atoms did not themselves cause the latter to give out an appreciable homogeneous secondary X-radiation. This result indicates that it is improbable that the homogeneous radiation from a metal is the result of bombardment of atoms. It appears probable that the atom from which the electron is ejected is the seat of production of the radiation. As the result of the loss of an electron the atomic system will have to adjust itself, and in so doing an electron may vibrate with an emission of the homogeneous secondary radiation. The effect may be similar to the emisson of radiations by fluorescent bodies. The attempt was made to detect a phosphorescent effect or the persistence of secondary X-radiation, but the experiment indicated that, whatever the nature of the effect inside the atom, it is rapidly damped in the case of Cu and Zn, and cannot continue in sufficient strength to give $\frac{1}{100}$th of the original secondary radiation after a period of $\frac{1}{1000}$ sec. J. J. S.

1437. *Photographic Method of recording α-Particles.* **W. Duane.** (Comptes Rendus, 151. pp. 228–230, July 18, 1910. Le Radium, 7. pp. 196–198, July, 1910.)—The number of α-particles given off per sec. from a radio-active substance, after allowing for the exponential decay, is not constant but varies according to the laws of probability. Consequently, to obtain an accurate estimate of the α-particles from a given source, it is necessary to count a large number, and the present paper deals with a method of automatically recording them. The principle of the method is that of Rutherford and Geiger, the ionisation produced by a single α-particle being augmented by collision so as to produce a sudden large ionisation current. The electrode of the ionisation chamber is connected to a gold-leaf electroscope, and the position of the leaf is registered on a travelling photographic film. The leaf is deflected corresponding to each α-particle and returns to its zero position by the charge being allowed to gradually leak to earth by means of the ionisation produced by polonium in the neighbourhood of an electrode connected to it. E. M.

1438. *Decrease of Velocity of β-Particles on passing through Matter.* **W. Wilson.** (Roy. Soc., Proc. Ser. A. 84. pp. 141–150, July 28, 1910.)—In a previous paper [Abstract No. 1888 (1909)] evidence was obtained that β-rays in passing through matter undergo a diminution in velocity, and in the present communication this question has been examined more in detail. In the experimental arrangement a beam of approximately homogeneous β-rays was separated out by a magnetic field from the β-rays from RaEm in equilibrium as far as RaC. This beam of rays, after passing through various sheets of matter, was deflected by a second magnetic field into a small opening in the base of an electroscope, the value of the field causing the max. ionisation current to be observed in the electroscope being used to calculate the velocity of the β-rays after emergence from the absorbing sheets. The initial velocity of the β-rays was varied in different experiments by means of the first magnetic field, and it was found in all cases that there was a decided diminution in velocity on passing through the sheets of matter. The curve of decrease of velocity with the thickness of matter (Al) traversed was found to agree well with values calculated on the assumption of the linear law of absorption found in the previous paper. E. M.

1439. *Distribution of Velocity in the β-Rays from a Radio-active Substance.* **J. A. Gray.** (Roy. Soc., Proc. Ser. A. 84. pp. 136–141, July 28, 1910.)—The paper deals with the question as to whether the β-rays from a single radio-active substance are initially projected at an identical speed or are emitted with varying velocities. The photographic method was used, a narrow pencil of β-rays being deflected by a magnetic field in an evacuated vessel. In the first experiments a mixture of RaB and RaC was used as β-ray source, this being obtained from RaEm in equilibrium, contained in a very thin-walled tube similar to the tubes used by Rutherford and Royds for allowing α-rays to penetrate [see Abstract No. 463 (1909)]. In the magnetic spectrum obtained from these β-rays no evidence of any homogeneous sets of β-rays could be observed. Further experiments were made using RaE as source of β-rays, these rays being such that their absorption by matter was accurately exponential. As in the previous experiment, it was found that the velocity of these β-rays was not identical but distributed between fairly wide limits. These experiments therefore confirm Wilson's results [see Abstract No. 1888 (1909)]. E. M.

1440. *β-Radiation and Atomic Weight.* **H. W. Schmidt.** (Zeitschr. Elektrochem. 16. pp. 606–610; Discussion, p. 610, Aug. 1, 1910. Paper read before the Deutsch. Bunsen-Gesell., Giessen, May, 1910.)—The paper contains a further discussion of the author's theory of the reflection and absorption of β-rays by matter [Abstract No. 1831 (1907)]. The theoretical results are compared with those of experiment chiefly with regard to the somewhat abnormal absorption of hydrogen compared with its density; and with the additive law of absorption as applied to various organic compounds containing hydrogen [see Abstracts Nos. 1152 and 1249 (1910)]. The experimental results are in good agreement with the theory, and suggest that in the passage of β-rays through matter, all peculiar properties of the matter are of no importance, the absorption being only dependent on the atomic weights of the constituents and two universal constants. E. M.

1441. *Heat evolved from a Mixture of Radium and a Phosphorescent Salt.* **W. Duane.** (Comptes Rendus, 151. pp. 379–381, Aug. 1, 1910.)—Using a very sensitive calorimeter [see Abstract No. 1073 (1909)], the author has observed that phosphorescent salts give up heat after having been under the influence of light. The experiments were extended to the question as to whether a mixture of a phosphorescent salt and radium gives off the same amount of heat as the radium salt itself. Zinc sulphide was used and it was found to have no influence on the heat evolved from the radium salt. Similar experiments were made with barium platinocyanide and willemite, but the α-radiation from the Ra was excluded, and again the presence of the phosphorescent substance was found to have no influence on the rate of evolution of heat, showing that there is no appreciable absorption or liberation of chemical or atomic energy by the phosphorescent substance. The author points out that the energy involved in a single visible scintillation is 8×10^{-7} erg, and this must be greater than the smallest amount of light-energy which can be detected by the eye. E. M.

1442. *Constituents of the Active Deposit of Actinium.* **Mlle. L. Blanquies.** (Comptes Rendus, 151. pp. 57–60, July 4, 1910. Le Radium, 7. pp. 159–162, June, 1910.)—Previous experiments have shown that although the Bragg ionisation curves obtained with polonium and RaC are superposable, yet the active deposit of Ac gives a curve of different form [see Abstract No. 1406 (1909)]. The authoress now explains this difference by assuming the presence of a new rapidly decaying product AcB′, giving off α-particles with a range little different from those of AcB. The following experiments are described in further support of this hypothesis. By electrolysis or by heat a deposit rich in AcB and containing little AcA is obtained, and it is found that the decay of this deposit after allowing for the AcA present is at first somewhat more rapid than if AcB alone were present. Recoil experiments also show irregularities which the new product would explain, while two α-ray products of slightly different ranges are indicated by experiments on counting the α-particles from the Ac active deposit at different distances from the source. E. M.

1443. *Radium-content of the Atmosphere.* **V. F. Hess.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 145–195, Feb., 1910.)—Previous work by Elster and Geitel, Gerdien, Kurz, and others, is dealt with, and then a description is given of the author's absolute determination of the induction content of the atmosphere. The observations extended from the middle of July to Oct. 8, 1909. The aspiration method was employed, but various improvements were introduced; an electrometer of very small capacity and great sensitiveness was used and the inner electrode was charged to a high negative potential, the outer tube being earthed together with the positive pole of the battery used. One hundred and sixteen measurements were taken. In by far the majority of cases only RaA was deposited on the active electrode. Only in six cases could a noticeable amount of RaB be detected from the form of the decay curve. The later portions of the decay curves indicated the presence of a small quantity of Th-induction. The mean value, deduced from all the observations, gave $\epsilon = 3{\cdot}45 \times 10^{-5}$ E.S. unit, ϵ being the saturation current given by the RaA and RaC contained in 1 m.^3 of air. In the measurements are included only such particles as carry positive charges and produce in an electric field movement of the normal atmospheric ions. The "carriers" of very small mobility (analogous to the ions of Langevin) are not included. The least value of ϵ was $0{\cdot}62 \times 10^{-5}$, and the greatest $10{\cdot}42 \times 10^{-5}$ e.s. unit. The induction content shows a daily variation with the following characteristics: The principal maximum occurs in the early morning (before 7 a.m.), then comes a minimum about 11.30 a.m. The second (secondary) maximum lies about 4 p.m., and the second (principal) minimum after 6 p.m. The amplitude of the daily variation of the induction is about $\pm 0{\cdot}60 \times 10^{-5}$ e.s. unit, *i.e.*, about 15 to 20 per cent. of the mean absolute value. The daily progress of the induction content is in general a reflection of the mean daily barometer variation, with a phase relation of about an hour. A maximum in the barometer curve is followed by a minimum of the induction curve, and *vice versâ*. The daily variation of the ions present in the atmosphere (measured with Ebert's apparatus) shows only a slight similarity to the variation of the induction. On the other hand, there is a distinct relation between the induction value and the number of ions present at the same time, both with regard to the number of positive ions I_+ and the mean total ionisation $\frac{1}{2}(I_+ + I_-)$. A calculation of this dependence of the intensity of ionisation q shows that for zero induction content the intensity of ionisation $q_0 = 1{\cdot}03$ ions per cm.³ per sec., and that with increasing induction content q increases proportionally. For the mean induction content $3{\cdot}45 \times 10^{-5}$ e.s. unit, q_0 increases by about 0·44(5), *i.e.*, about 43 per cent. Hence it appears that on the average the induction content of the atmosphere produces about 30 per cent. of the measured ionisation. The before-mentioned variation of the induction content serves to explain the variation of the ionisation of the atmosphere if one takes into consideration the fact that the intensity of ionisation due to the penetrating rays undergoes variations also owing to the active deposits. As regards the influence of weather conditions the following conclusions are drawn: The induction content appears to have no relation to the height of the barometer, but only to variations of the atmospheric pressure. Falling pressure increases the induction content, and increasing pressure shows a decreased induction. Simultaneous observations of the number of ions and the air pressure show no connection. High temperature gives large induction values, and similarly with a cloudless sky high values are usually obtained, while with a cloudy sky low values are found. With increasing humidity the induction also increases. During and after heavy rain the smallest values of the induction content were found. With fog, somewhat above the normal values were obtained. A dependence was established on wind direction and strength. With southerly and westerly winds high induction values were found; with increasing wind strength the induction content also rose. The paper concludes with a table of all results, showing weather conditions, &c., in each case. A. W.

1444. *Radio-activity of the Rocks of the Transandine Tunnel.* **A. S. Fletcher.** (Phil. Mag. 20. pp. 36–45, July, 1910.)—The Ra, in gm. $\times 10^{-12}$ per gm., of 19 specimens ranged from 0·32 up to 1·40. The Th, in gm. $\times 10^{-5}$ per gm., from 0 up to 1·11. In two cases there was no Th, but Ra was found in all. The mean ratio of the Th-content to the Ra-content is $0{\cdot}71 \times 10^7$, as compared with Joly's value $0{\cdot}65 \times 10^7$. L. H. W.

1445. *Amount of Radium Emanation in the Atmosphere and its Variation with the Weather.* **J. Satterly.** (Phil. Mag. 20. pp. 1–36, July, 1910.)—The author gives details of a systematic determination of the amounts of RaEm in the atmosphere at Cambridge, at intervals during a year. The method of measurement was that of absorbing the emanation from a constant stream of air by cocoanut charcoal, and has been previously employed by the author for the same purpose [see Abstract 1964 (1908)]. The author has analysed and compared the results obtained with the meteorological conditions existing at the time they were made; and has also made them absolute by comparison with radium standards. The average radium equivalent per m.³ was found to be 105 × 10^{-12} gm., the lowest value 85 × 10^{-12} and the highest 850 × 10^{-12}. The results show that the amount of emanation is usually lowest during cyclones, and highest during anticyclones; while in cases where this does not hold, a study of the trajectories of the surface air-currents reveals that when air has travelled over the sea to Cambridge or very rapidly over land, the emanation content is low, while, if the air has spent much time over land, the emanation content is high. The author also discusses the results of other investigators. E. M.

REFERENCES.

1446. *Adjusting a Spectrograph.* **P. Joye.** (Journ. de Physique, 9. pp. 491–509, June, 1910.)—The author enters fully into the technique of the necessary adjustments. The type of instrument dealt with is that of Steinheil, having strong illumination. [See Abstract No. 711 (1905) L. H. W.

1447. *Parallax Stereograms.* **G. O.'t Hooft.** (Zeitschr. wiss. Phot. 9. pp. 1–12, Aug., 1910.)—A discussion of parallax stereograms, in which the picture is viewed by the two eyes through a ruled grating, each of whose bars shades off from the one eye a strip of the picture which the other eye sees, and *vice versâ* for the other eye; Ives's camera with wide lens and two diaphragm apertures; Schram's with displaceable back; the author's camera. A. D.

1448. *Light and Chromogelatine.* **H. Mayer.** (Journ. de Physique, 9. pp. 584–599, July, 1910. Extract from Comptes Rendus de la Soc. royale de Sciences de Prague.)—Electrical method of measuring the effect of light. A. D.

1449. *Metallic Dispersion.* **A. L. Bernoulli.** (Ann. d. Physik, 33. 1. pp. 209–224, Aug. 5, 1910.)—A discussion of the determination of the dispersion of metals by the method of minimal azimuths and in reply to W. Voigt. [See also Abstract No. 1394 (1909).] E. H. B.

1450. *Additional Refractive Indices of Quartz, Vitreous Silica, Calcite, and Fluorite.* **J. W. Gifford.** (Roy. Soc., Proc. Ser. A. 84. p. 193, July 28, 1910.)—The indices have been determined of the above materials for the following rays: $\lambda=6708$ Li, $\lambda=6438$ Cd, $\lambda=5461$ Hg, $\lambda=5086$ Cd, $\lambda=4800$ Cd, $\lambda=4359$ Hg, $\lambda=4046$ Hg. E. C. C. B.

1451. *A Relation between Band Spectra and Chemical Dissociation.* **J. Koenigsberger** and **K. Küpferer.** (Phys. Zeitschr. 11. pp. 568–571, July 1, 1910.)—The authors conclude that the banded absorption spectra in such cases as iodine, sulphur, &c., are due to the electronic oscillations which occur with a reversible chemical dissociation. E. C. C. B.

1452. *The Band-spectrum obtained with Manganese Chloride in the Oxygen-Coal-Gas Blast Flame.* **H. Casaretto.** (Zeitschr. wiss. Phot. 8. pp. 381–404, July, 1910.)—The introduction of the $MnCl_2$ into the flame was carried out by Hartley's method. The powdered salt was wrapped tightly in a roll with filter paper and was slowly and regularly pushed into the flame. The measurements of wave-length were made upon photographs taken with a 1-m. focus grating, and extend from $\lambda=6707$ to $\lambda=4402$. Some important regularities were noted in the distribution of the lines in the bands. E. C. C. B.

1453. *Emission and Absorption of Luminescent Hydrogen.* **R. Ladenburg.** (Deutsch. Phys. Gesell., Verh. 12. 14. pp. 549–564, July 30, 1910.)—The author in a previous paper has stated that results obtained by himself, and also those of Pflüger, with respect to the reversal of the hydrogen lines, afford a clear proof that Kirchhoff's law is not obeyed, and that, therefore, the radiations of luminescent hydrogen are not temperature radiations. This contention has been refuted by Pflüger [Abstract No. 909 (1910)]. The present communication contains a historical survey of the question, a critical analysis of it, and finally some fresh experimental data which are brought forward as proving that Pflüger's objections are groundless.
A. E. G.

1454. *The Intensity Minimum of the Cyanogen Group* λ3883·558. **J. W. Haferkamp.** (Zeitschr. wiss. Phot. 9. pp. 19–35, Aug., 1910.)—An investigation of variations in the intensity of the great group in the cyanogen band spectrum with change of pressure and variations in the electric discharge. E. C. C. B.

1455. *The Difference between Longitudinal and Transverse Zeeman-effect.* **P. P. Koch.** (Phys. Zeitschr. 11. pp. 612–614, July 15, 1910.)—Nagaoka has stated that in certain cases the magnetic resolution of a line viewed at right angles to the force lines is not proportional to the field strength in weak fields [Abstract No. 247 (1910)]. The author concludes that these observations are due to experimental error in measuring the lines, owing to the increase in their breadth. E. C. C. B.

1456. *Experimental Decision between the Æther-wave and Light-quantity Hypotheses.* **J. Stark.** (Phys. Zeitschr. 11. pp. 24–31, Jan. 1, and pp. 179–187, March 1, 1910.)—A further contribution [see Abstract No. 250 (1910)]. **A. Sommerfeld.** (Ibid. pp. 99–101, Feb. 1, 1910.)

1457. *Radium Induction in the Atmosphere.* **J. Salpeter.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 107–118, Feb., 1910.)—A further mathematical discussion of the influence of the earth's field on the distribution of Ra-induction in the atmosphere and on the earth's surface [see Abstract No. 925 (1910)]. A. W.

1458. *Experimental Determination of the Nature of the γ-Rays.* **E. v. Schweidler.** (Phys. Zeitschr. 11. pp. 614–619, July 15, 1910.)—This forms the second part of a theoretical paper [see Abstract No. 938 (1910)] in which the method of deciding experimentally between the corpuscular and impulse theories is considered.
A. E. G.

HEAT.

1459. *A Compensation Thermometer.* **H. F. Wiebe.** (Zeitschr. Instrumentenk. 30. pp. 245–254, Aug., 1910. Communication from the Physikal.-Techn. Reichsanstalt.)—Changes in the zero-point of mercury thermometers are of two kinds—temporary, and permanent. Hoffmann and others, since 1897, have introduced compensation devices. The present one is due to O. Schott. He makes the thermometer itself of glass having small thermal after-effect, and introduces into the mercury bulb a piece of glass having large thermal after-effect. Knowing the values of the after-effect in both kinds of glass, it is easy to decide what volume of the latter glass is required in the bulb. The results of experiments lasting several years are given in a series of tables, and are very satisfactory. P. E. S.

1460. *Simple Dynamic Method of determining Vapour Pressure.* **A. Smith** and **A. W. C. Menzies.** (Roy. Soc. Edinburgh, Proc. 30. pp. 437–439, 1909–1910. Abstract.)—The submerged bulblet apparatus described in Abstract No. 1279 (1910) is adapted for determining vapour pressures. The small bulb half filled with liquid is attached by its ∩-shaped stem to the stem of a thermometer; the latter is enclosed in a test-tube containing a portion of the bath liquid. The interior of the test-tube communicates with a gauge, a pump, and with the atmosphere. Starting with the pressure greater than that of the vapour in the bulb, the pressure is lowered gradually until a continuous stream of bubbles is seen; then the pressure is allowed to rise until the stream ceases, readings of the gauge being taken. The working of the apparatus is illustrated by a table of readings of the vapour pressure of water between 49° and 95°, these agreeing well with those of Holborn and Henning. G. E. A.

1461. *Conductivity of the Inner Cone of Divided Flames and Explosion of Gas Mixtures.* **F. Epstein** and **P. Krassa.** (Zeitschr. Phys. Chem. 69. 1. pp. 28–46, Jan. 18, 1910.)—The authors have determined the conductivity of the inner cone of flames of coal-gas and air and of CO and air, both with and without the addition of a certain quantity of the products of combustion. The temperature of the top of the cone was measured by means of a thermo-element. The gases were supplied through a tube separately from the air or oxygen and allowed to mix in the burner tube. The electrodes consisted of two Pt-Ir wires 0·05 mm. thick and covered with magnesia. The conductivities were measured at different distances between the electrodes and at different heights above the tip of the cone. At heights of about 1 mm. above the point of the cone and with electrodes 1 mm. apart, the conductivity was only ⅓ to ¼ of that found when the wires were in contact with the point of the cone. F. J. B.

1462. *Radiation in a Gaseous Explosion.* **B. Hopkinson.** (Roy. Soc., Proc. Ser. A. 84. pp. 155–172, July 28, 1910.)—Previous experiments made by the author with a vessel lined with bright tin-foil are noticed in Abstracts Nos. 1015A (1907) and 920B (1909). The present series of tests was made with the interior surface of the cast-iron vessel electroplated with silver;

first highly polished and then blackened. As in the vessel lined with tin-foil, the cooling is slower when the walls are reflecting, but the difference is greater with the silver-lined vessel, amounting to about 50 per cent. during the first quarter of a second. There is also a difference in max. pressure amounting to about 8 per cent. In this series records were obtained of the change of temperature during explosion and subsequent cooling, from a bolometer placed outside a window of fluorite in the wall of the vessel, and these showed that for one-tenth of a second after max. pressure about one-third of the whole heat-loss to black walls is due to radiation, and that radiation is still perceptible half a second after max. pressure. Both pencil and optical indicators were used. The following table shows the time (from the moment of ignition) taken by the gas to cool to 1700° and 1200° C. respectively with different surfaces. Since the heat lost by the products of explosion in cooling to a given temperature must be very nearly the same whatever the state of the walls, the times are inversely proportional to the mean rate of cooling. This ratio is shown, the rate of cooling with black walls being taken as the unit. The rate of loss of heat to the polished surface varies in different observations from rather over half to about three-quarters of the loss to the black walls.

Record No.	1700° C.			1200° C.		
	Black.	Polished.	Ratio.	Black.	Polished.	Ratio.
Pencil—						
14, 16, 17.........	0·178	0·320	0·56	0·297	0·567	0·52
18, 20, 21.........	0·177	0·289	0·61	0·302	0·478	0·64
Optical—						
I., II., III.	0·198	0·269	0·72	0·320	0·455	0·70
IV., V., VI.......	0·196	0·277	0·71	0·327	0·450	0·73

Comparisons similar to these with tin-foil lining showed that the ratio of cooling to 1200° C. was about 0·87, so that the tin-foil reflects for this purpose less than half as well as silver. Construction and arrangement of the bolometer and circuits, and diagrams and tables of results are given. It appears that the mean rate of absorption during the first quarter of a second by the polished surface is 0·74 of the absorption by the blackened surface; the mean rate of cooling in a polished vessel during the same period as observed in the pressure experiments was from 0·56 to 0·71 of the blackened surface rate. The bolometer also shows the same approximation of the rates of cooling in the two cases. It is held as certain that at least 80 per cent. of the heat given by the gas to the blackened walls during the first quarter second after max. pressure is radiant heat, and probably the proportion is higher. Determination of the quantity of heat-loss represented by rise of temperature of the bolometer strip; and of the absolute quantities of heat absorbed by the blackened and polished surfaces per unit area at different times, conclude the paper. F. J. R.

1463. *Statistical Theory of Heat Radiation.* **H. A. Wilson.** (Phil. Mag. 20. pp. 121–125, July, 1910.)—In Larmor's generalisation of Planck's theory of radiation [see Abstract No. 704 (1910)], the radiation is considered as made up of "elements of disturbance" which are regarded as definite entities possessing energy, but the energy in an element is supposed to be capable of continuous variation. The author, starting with Boltzmann's expression for the entropy, and utilising Larmor's results and the expression of the energy for long waves obtained by H. A. Lorentz and Jeans, concludes that Larmor's theory seems to require the radiation to be made up of finite elements of the same magnitude as those contemplated by Planck and Einstein. He finds that the energy per element of disturbance of a particular wave-length cannot be made indefinitely small. The average energy per element of disturbance in the radiation he finds equal to 1·8 times the energy of a monatomic gas molecule, and that for a given pressure and temperature, a gas contains 0·9 times as many molecules per c.cm. as full radiation contains elements of energy. G. W. DE T.

REFERENCES.

1464. *A Constant-pressure Gas Thermometer.* **W. Miller.** (Phil. Mag. 20. pp. 296–302, Aug., 1910.)—Illustrated description with examples of application.

1465. *Measurement of the Thermal Conductivity of Fireclay.* **J. K. Clement** and **W. L. Egy.** (Metallurgical and Chem. Engin. 8. pp. 414–416, July, 1910. Abstract from Bull. 36 of the Engineering Experiment Station of the Univ. of Illinois.)—A cylinder of fireclay 40 cm. × 12 cm. diam. is heated electrically by means of a nickel-wire spiral passing through a hole along its axis. The whole is insulated, and for a considerable distance about the middle, heat travels radially through the cylinder, the conductivity being measured by thermo-couples placed at various distances from the axis. The results on twelve different clays are discussed, and it is interesting to note that, while the conductivity of fine clay increases with the temperature, that of coarse clay is constant. F. C. A. H. L.

1466. *Revision of the Equilibrium Conditions in Gases. Thermic Molecular Streaming.* **M. Knudsen.** (Ann. d. Physik, 31. 1. pp. 205–229, Dec. 30, 1909.)—This paper is not suitable for abstraction ; the original must be consulted. F. J. B.

1467. *Equations and Tables for Saturated and Superheated Nitrogen.* **R. Plank.** (Zeitschr. f. d. ges. Kälte-Industrie, 1910. Phys. Zeitschr. 11. pp. 633–643, July 15, 1910.)—The paper deals with the general theory and the equations of state are developed. From published numerical data the various formulæ are tested. For details the original paper must be consulted. F. J. B.

1468. *Continuous and Stable Isothermal Change of State.* **W. Peddie.** (Roy. Soc. Edinburgh, Proc. 30. pp. 466–472, 1909–1910.)—A theoretical discussion not suited for abstraction. A. F.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1469. *Electrodynamic Significance of Planck's Radiation Law and a New Determination of Electron Charge and Size of Hydrogen Atom.* **A. E. Haas.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 119–144, Feb., 1910.)—The author points out certain relations between Planck's law as to radiation and resonance and electrodynamic theory; and then by aid of the constant in Balmer's spectrum formula calculates the charge e and the radius a of the hydrogen atom. His values are: $e=3·18\times10^{-10}$ e.s. unit and $a=1·88\times10^{-8}$ cm.

E. H. B.

1470. *Scattering of rapidly moving Electrified Particles.* **J. J. Thomson.** (Cambridge Phil. Soc., Proc. 15. pp. 465–471, June 14, 1910.)—When rapidly moving electrified particles pass through matter, each particle as it passes through an atom of the substance, or perhaps even when it passes close to such an atom, is deflected. The amount of the deflection will vary with the way the particle strikes the atom; there will, however, be a mean value for the deflection produced by an atom on the direction of motion of a particle passing through it, and when we are considering only the effects produced by large collections of particles we may suppose that the path of each particle suffers the mean deflection. The direction of this deflection is quite arbitrary. The paper then considers the case when a large number of particles pass through a large number of atoms, and shows that, by a known theory of probability, the average value of the resultant of n displacements of arbitrary phase and of constant amplitude θ is $\theta\sqrt{n}$. Thus, if the electrified particles are corpuscles moving normally through a plate of thickness t, then if there are N atoms per unit volume of the plate, and if b is the radius of an atom, the number of atoms traversed by a particle on its journey through the plate is $N\pi b^2t$, and hence the mean value of the deflection experienced by a particle when passing through the plate is $\theta\sqrt{N\pi b^2t}$. This supposes that the particle is not deflected so much in passing through the plate as to make its path length differ materially from t. The calculation of θ is then proceeded with and its expression is found to contain no unknown factor except N_0, the number of corpuscles in an atom. The theory thus furnishes a clue to the experimental determination of N_0 which was undertaken by J. A. Crowther. But, in the meantime, from experiments by Becker it is known that kathode rays of a certain definite velocity passed through about 0·5 cm. of oxygen before the number moving forwards was reduced to half. And from this the author finds N_0 for oxygen to be of the order 50, this being slightly over three times the number for its atomic weight.

E. H. B.

1471. *Electric Charges in Phosphorus Mist.* **K. Przibram.** (Phys. Zeitschr. 11. pp. 630–632, July 15, 1910.)—Adopting the method of F. Ehrenhaft of observing microscopically the path of particles in the gravitational and electrical fields, the present author deals with the mist or cloud obtained from moist air and phosphorus. The latest experiments show a charge from 3 to 6 $\times 10^{-10}$ e.s. unit with a mean value 4·4 $\times 10^{-10}$.

E. H. B.

1472. *Observations of Atmospheric Electricity at the Island of Petermann by the Charcot Expedition.* **Rouch.** (Comptes Rendus, 151. pp. 225–228, July 18, 1910.)—The paper deals with the results of electrical observations at the island of Petermann (lat. 65° 10′ S., long. 66° 34′ W.) during a stay of ten months. The atmospheric potential gradient was measured by a radium collector method, and the analysed results show an average maximum of 288 volts/m. in Feb. and a minimum of 98 in June. This variation is similar to that observed in the Northern Hemisphere, showing that it is not a seasonable variation. The diurnal variation of the potential gradient gave a maximum at 8 p.m., and an ill-defined minimum at midnight. Observations on the conductivity of the air showed that its variation was inversely as that of the potential gradient, while its average value was somewhat greater than in intemperate regions. Radio-activity measurements were made of rain, snow, ice, &c., but in no case could any activity be detected. E. M.

DISCHARGE AND OSCILLATIONS.

1473. *Photo-electric Experiments with Anthracene.* **A. Byk** and **H. Borck.** (Deutsch. Phys. Gesell., Verh. 12. 15. pp. 621–651, Aug. 15, 1910.) —The researches carried out by Pochettino [Abstract No. 1279 (1906)] on the photo-electric effect obtained with anthracene do not appear conclusive, since the anthracene was placed upon a copper plate and no attempt was made to ascertain the behaviour of that plate with respect to light when no anthracene was present. This point is now investigated and the conclusion arrived at that anthracene acts as a good insulator in this connection. The primary action of light on anthracene appears to consist in the splitting-off of electrons, or, in any case, in a breaking-up of neutral molecules into two oppositely charged particles. A. E. G

1474. *Flames producing Small Ions.* **M. de Broglie.** (Comptes Rendus, 151. pp. 67–68, July 4, 1910.)—In a previous paper the author has shown that ions produced by a flame of CO have a mobility of the same order as that of those produced by Röntgen rays or by the rays from radio-active substances [see Abstract No. 956 (1910)]. In the present communication experiments are described showing that flames of hydrogen, pentane vapour, ether vapour, &c., can, under suitable conditions, be made to give exclusively ions of the same high mobility. In the experimental arrangement the combustible gas or vapour is diluted with nitrogen and caused to burn with a small flame at the end of a lead tube surrounded by a water-cooled tube, the reacting gases being carefully dried and filtered. E. M.

1475. *Production of Kathode Particles by Homogeneous Röntgen Radiations.* **R. T. Beatty.** (Cambridge Phil. Soc., Proc. 15. Part 5. pp. 416–422, June 14, 1910. Phil. Mag. 20. pp. 320–330, Aug., 1910.)—When Röntgen radiations fall upon various substances, kathode particles are produced. The velocities of these particles are independent of variations in the intensity of the Röntgen radiations used, and are also independent of the nature of the substance struck. On the other hand, the velocities increase or decrease with an increase or decrease in the penetrating power of the Röntgen radiations [see Abstracts Nos. 1670, 1828 (1907)]. When a very thin silver leaf is placed in the path of homogeneous radiations, kathode particles are shot out from its surface. The absorption of these particles in air and in hydrogen is investigated. Plates of Fe, Ni, Cu, Zn, As, and Sn are used as radiators. A homogeneous radiation proceeds from the radiator; part of this enters a cylindrical brass chamber A through a thin parchment window. It then passes through a silver leaf and is finally totally absorbed in a thick brass disc which, being connected to an electroscope, serves as electrode. This disc is covered with paper to prevent the emission of kathode particles from the surface. Another portion of the radiation enters a primary electroscope which serves to standardise the amount of homogeneous radiation emitted by the radiator. The chamber A is kept at a potential of 200 volts, so that on breaking the earth connection while the bulb is in action, a charge is given to the brass electrode. The pressure of the air in A is varied and the ionisation between the silver leaf and the brass disc measured. This ionisation is due to two causes: (1) Röntgen radiation, and (2) kathode particles emerging from the silver leaf. A figure is given which shows how the ionisation due to each of these causes varies with the pressure and how the actual curve found is the sum of these separate effects. From the results obtained it is concluded that the amount of energy spent by the incident radiation in producing kathode particles is proportional to the energy of that radiation which is absorbed by the leaf. It is also found that the ratio (Range of kathode particles in hydrogen)/(Range of kathode particles in air) increases as the kathode particles become more penetrating, but that the total ionisation produced by a given bundle of kathode rays is the same in hydrogen as in air. When the apparatus is modified so as to be able to compare the ionisations in hydrogen and air due to homogeneous Röntgen radiations, it is found that the former is only a very small fraction of the latter. The relations among kathode particles excited by homogeneous Röntgen radiations described in this paper do not in all cases agree with the results obtained by Sadler [see Abstract No. 2059 (1909)]. A. E. G.

1476. *Direction of Motion of an Electron ejected from an Atom by Ultra-violet Light.* **R. D. Kleeman.** (Roy. Soc., Proc. Ser. A. 84. pp. 92–99, July 8, 1910.)—When ultra-violet light is absorbed by matter, we know that a part, at least, of the absorbed energy is expended in liberating kathode rays of small velocity. The momentum corresponding to the absorption of energy in this case thus probably appears in part in the form of moving electrons. It is to be expected, therefore, that these kathode rays will have a component of velocity in the direction of the propagation of the light. The object of the present paper is to investigate this point. A quartz plate covered on one side with a very thin film of Pt deposited on it from a Pt kathode in a discharge tube, is used as target for the light. It is shown that this Pt film emits practically only negative particles under the action of the ultra-violet light, while the corresponding positive charge remains on the film. The quartz target is so arranged that it can be rotated, and the side on which there is no Pt film is exposed to the action of the light. If we denote by unity the intensity of light entering the film, then it is found that the intensity of light emerging at the other side is 0·55, and if the intensity of the kathode radiation on the side where the light enters is denoted by unity, the intensity of radiation on the other side is 1·15. This seems to show that the ejected electrons have a component of motion in the direction of propagation of the light. These experiments were carried out with air in the chamber at atmospheric pressure. A set of experiments was carried out when the chamber in which the target is placed was evacuated, and similar results were obtained. This result is of interest in connection with the action of light on free electrons, for it seems reasonable to expect that a forward motion would also be given to an electron when not associated with an atom, on a wave of light passing over it. The experiments thus afford evidence in support of the theory that some of the free electrons which exist in the solar atmosphere, or in the atmosphere of any incandescent heavenly body, are driven into interstellar space by the light of the body. A. E. G.

1477. *Ionisation in Dried Air.* **S. G. Lusby.** (Cambridge Phil. Soc., Proc. 15. pp. 459–464, June 14, 1910.)—The condensation experiments of C. T. R. Wilson suggest that negative ions act more readily than positive ions as nuclei for the condensation of water-vapour, and the present experiments were undertaken to find whether, on suddenly drying damp ionised air a residual positive charge would be shown. Ordinary unfiltered and undried air was ionised by passing over Ur and dried by being passed through a copper **U**-tube immersed in liquid air; thence it was passed into a Faraday cylinder connected to an electroscope, but no residual charge could be detected. To further test the matter the Faraday cylinder was replaced by an apparatus to measure separately the positive and negative charges carried by the ions. These charges were found to be exactly equal but several times larger in magnitude than if the copper **U**-tube were not immersed in liquid air. Further experiments showed that this effect was due to a decreased rate of recombination in the air passed over liquid air, owing to the low temperature having removed all the large molecular aggregates or nuclei, the water-vapour taking practically no part in the action. E. M.

1478. *Doppler-effect in Rotating Mercury Arc.* **A. Dufour.** (Comptes Rendus, 151. pp. 60–63, July 4, 1910.)—In the experiments described an arc was formed between two circular and concentric mercury electrodes separated by a vertical quartz tube, at a pressure of about 1 mm. Hg. On applying a magnetic field along the axis of the electrodes the arc revolved with great rapidity. The author gives photographs taken by means of a Fabry and Perot interferometer, showing that the Doppler-effect can be noticed in the light from the edge of the rotating arc; the Zeeman-effect having been eliminated by using a suitably orientated nicol. The change of wave-length due to the Doppler-effect was several times smaller than that to be expected if the luminous vapour partakes of the same speed of rotation as the arc itself as determined by a revolving-mirror method. A dissymmetry was noticed in that the change of wave-length when the arc was travelling away from the observer was greater than when it was approaching. The author explains this as due to the anomalous dispersion of the surrounding vapour. E. M.

1479. *The Generation of Free Electrons in Chemically Inert Gases at Atmospheric Pressure.* **J. Franck.** (Deutsch. Phys. Gesell., Verh. 12. 14. pp. 613–620, July 30, 1910.)—In its electrical behaviour nitrogen stands in closer relationship to the rare gases than any other gas. The electrical properties of nitrogen, like those of the rare gases, are affected by the introduction of small quantities of another gas, especially oxygen. The kathode-fall in pure nitrogen is much greater than when that gas contains traces of oxygen or hydrogen, and the same applies to gases of the argon group. The minimum potential of the spark discharge is also affected in a similar manner. It appears as if these peculiarities are in some way connected with the rate of motion of the ions in these gases. When nitrogen has been carefully purified, it is found that the average velocity of the positive ions is 1·27 cm./sec. per volt/cm., while that for the negative ions is about 100 cm./sec. On the other hand, in nitrogen containing traces of oxygen the results are 1·80 cm./sec. for positive ions, and 1·84 cm./sec. for negative ions. This is quite analogous to the behaviour of argon in the case of negative ions. In pure argon these are found to move about 200 times quicker than positive ions, but this velocity sinks to about 1/150th part of its value when only about 1 per cent. of oxygen is mixed with the argon. In argon the highest obtained value for the velocity of the negative ions is 206·4 cm./sec., and with nitrogen it is 144·6 cm./sec. Whether this difference is a real one or is only due to difference in the degree of purity of the gases used is not decided. If, on account of its electronegative character, oxygen hinders the possible existence of free electrons, other electro-negative substances if mixed with nitrogen should affect that gas in a similar manner. One per cent. of chlorine is therefore introduced into pure nitrogen and the velocity obtained for the negative ions is then only 1·56 cm./sec. Moisture and nitric oxide have also a similar action when introduced as impurities. The differences in the electrical behaviour of the rare gases and nitrogen can be explained by the greater life-duration of electrons in these gases. A. E. G.

1480. *Temperature and Potential-pressure Relations in the Mercury Arc.* **C. T. Knipp.** (Phys. Rev. 31. pp. 97–116, Aug., 1910.)—It has been shown that the average temperature of the mercury arc increases from relatively low to very high values depending upon the voltage impressed and the form of the lamp used. Temperatures up to 1700° C. have been observed by Küch and Retschinsky. The average temperature of a mercury arc in a vertical tube is now investigated from electrode to electrode for pressures up to 8 mm. Hg at a constant current of 3 amps., by means of a movable thermo-junction introduced through the barometic leg of the lamp. The temperature increases very rapidly with the pressure. It is pointed out that the cooling effect may readily mask the temperature readings. In this particular instance this effect is due to the comparatively cool mercury surface forming the kathode and to the conduction of heat away from the junction by the wires. The temperature gradient along a diam. 27 mm. from the anode shows a fall in temperature of 20 per cent. of the whole at a distance of 12 mm. from the axis in a tube 34 mm. diam. The temperature readings are shown to be approximately independent of the nature of the radiating surface enclosing the thermo-junction. The potential gradient for various distances from the anode is shown plotted against pressures. The increase is small near the anode, but becomes greater as the kathode is approached. The relation between potential and pressure is also shown to be approximately a linear one. A. E. G.

1481. *Forces at the Surface of a Needle-point discharging in Air.* **A. P. Chattock.** (Phil. Mag. 20. pp. 266–277, Aug., 1910.)—When a sharp point discharges positive electricity into the air at atmospheric pressure, it is usually capped with a luminous velvety layer, which is probably not more than one or two hundredths of a mm. in thickness. This layer and the air near it is the region in which ionisation occurs. Hence ions of opposite sign travel in it, towards and from the point respectively. The author shows that it is possible to calculate the strength of the ionising field at the point to within ·1 or 2 per cent. for a positive electrification, in terms of the mechanical pull upon its surface; for a negative electrification the accuracy will not be so high. This conclusion holds when the point is supplied with ions of opposite sign to itself from a second point in its neighbourhood. It is stated that the electric "windmill" moves because the bent part of the spokes is pulled more strongly at the blunt end than at the sharp end. If the blunt ends be electrically shielded the rotation is in the opposite direction. A. R.

1482. *Ionising Processes at a Point discharging in Air.* **A. P. Chattock** and **A. M. Tyndall.** (Phil. Mag. 20. pp. 277–290, Aug., 1910.)—In explaining the phenomena of discharge at sharp points in gases under normal conditions, J. J. Thomson postulates an initial ionisation of a few isolated molecules in the gas as a preliminary to the process of discharge. Suppose a point to be gradually charged with positive electricity in the presence of these isolated ions. The field near the surface is at first unable to do more than clear them away as fast as they are formed; but as soon as it is strong enough to impart to the positives among them sufficient energy to enable these to ionise fresh molecules in their turn, ordinary positive discharge sets in, and a large current may result, accompanied by glow at the point and wind. In the case of a negative point, the field has also to reach a high enough value to enable the initially formed positive ions to form fresh ions; but they now have the alternative of doing this where they bombard the surface of the metal instead of in the gas, and the field required is not necessarily so high as when gaseous molecules are to be ionised. For both kinds of discharge the supply of positive ions is kept up by ionisation due to negative ions, these having been produced by previously formed positive ions, and so on. Both kinds of ion have therefore to be able to ionise, as each produces the other; and since positive ions require a stronger field for this than negative, it is always the field required by the positive ions which has to occur at the point. There are three distinct cases of the discharge when the point is positively charged: (*a*) If the external ions find a field at the point less than that required for negative ions to ionise, they will simply pass to the point and give rise to a current from it equal to that which they themselves carry; (*b*) if the field lies between that required for negative and that for positive ions to ionise, each external ion will produce several more before reaching the point, and the current resulting may be a considerable multiple of that carried by the external ions; (*c*) if the field exceeds that in which the positive ions are able to ionise, the double ionisation by both positive and negative ions will accompany the ionisation by the external ions, and a current due to ordinary positive point-discharge will be added to that of the external ions. With the point negatively charged these cases reduce to (*a*) and (*c*), the signs, of course, being interchanged. These principles are illustrated by means of the following experimental arrangement: A horizontal Pt wire P, with its end rounded to a hemisphere in the blowpipe, is suspended so that it protrudes through a hole in a vertical metal plate Q. P and Q are both earthed, Q directly and P through a galvanometer. Opposite P and in the same vertical plane is a sharp sewing-needle N connected to a Wimshurst, and so arranged that the vertical component x and the horizontal component y of its distance from P can be varied. The radius of P (0·081 cm.) is about seven or eight times greater than that of N, so that N discharges more readily than P, and the tendency of N to start first is further increased by surrounding P with a wire ring about 11 mm. diam. with its plane about 7 mm. behind the point P. By varying x and y it is thus possible to supply P with varying numbers of ions from N both before and after P itself begins to discharge on its own account. It is found that there is a certain hysteresis in the appearance and disappearance of the glow, especially for small values of y. This hysteresis is perhaps connected with the fact that when P begins to discharge it sends positive ions to N. These, by rendering the escape of corpuscles easier, may increase the average ionising power of the negative ions sent to P, and so diminish the field necessary for the glow, and therefore, indirectly, the current. As a result of the experiments it is concluded that a supply of negative ions from without to a positively electrified point lowers the ionising field at its surface; but when positive ions are supplied to a negative point they are without effect when the point is new. These two facts are shown to be consistent with accepted theory. A negative point may become aged with use, but temporarily acquires the properties of a new one when bombarded with positive ions. The minimum ionising field for fully formed negative ions is about one-half, and that for corpuscles about one-seventh of the field in which ordinary positive point-discharge takes place. In each case the field is measured at the surface of the metal. A. E. G.

1483. *The Silent Discharge through Air.* **D. H. Kabakjian.** (Phys. Rev. 31. pp. 117–121, Aug., 1910.)—In order to obtain steady discharges the author covers one of the electrodes with mica, 0·05 mm. in thickness, and charges from a transformer fed by 60-∿ current. With an air-gap of 1 mm. the current was very weak, until a potential of about 2,500 volts was reached, when it rose rapidly. In the oscillograph experiments discs of tin-foil, 2·40 cm. in diam., were mounted on glass, one of the discs being covered with mica, 3 cm. in diam.; the air-gap was diminished from 1·6 mm. to contact. The discharge was oscillatory, and the curves became more smooth as the capacity was increased or the air space decreased; variations in the current intensity and insertion of 88,000 ohms in the circuit did not affect the shape of the curves. In moist air the leakage current was noticeably greater before the discharge-point was reached than in dry air; but the opposite held afterwards, that is to say, the discharge current was smaller for moist air than for dry air. When both electrodes were covered with mica and a disc of wire gauze was interposed between them, no luminosity was observed at all in moist air, when the mica discs and gauze were in contact. H. B.

1484. *Ozone Formation by the Silent Discharge.* **D. H. Kabakjian.** (Phys. Rev. 31. pp. 122–134, Aug., 1910.)—The author mounts his electrodes on glass discs within a cylindrical vessel; the one electrode is fixed, the other carried on a screw spindle; one of the electrodes is covered with mica or glass of different thicknesses. The air leaves the vessel through a tube which passes through the fixed disc at the centre. The air is passed through a meter, sulphuric acid, P_2O_5, glass-wool and cotton-wool before entering, and through water and KI after leaving. The quantity of ozone produced after a full discharge is established (not before), is almost proportional to the current and independent of the voltage; this proportionality cannot be explained by re-decomposition or de-ozonising due to the current. But a given current does not produce the same amount of ozone in ozonisers of different sizes and capacities; the yield per coulomb increases with increase in air-space or decrease of capacity. No definite voltage is required to produce ozone, which is already formed at 800 volts. The observations support the assumption that the oxygen molecule is dissociated into atoms by the ions or electrons carrying the discharge, and that the atoms are rearranged to ozone. H. B.

1485. *Potential Gradient with very Weak Discharges in Wehnelt Kathode Tubes.* **J. Würschmidt.** (Deutsch. Phys. Gesell., Verh. 12. 15. pp. 652–660, Aug. 15, 1910.)—Measurements of the kathode-fall with feebly glowing Wehnelt kathode gives with higher current strengths the approximately constant value 45–50 volts; with diminishing current the kathode-fall increases. The anode-fall amounts at most to 50 volts; the alteration of the strength of the current has no influence, but perhaps the condition of the anode has, since, after long use, values up to 80 volts are obtained. Starting with currents of the order 10^{-9} amp. the potential gradient increases with increasing current, quickly at first, then more slowly; ultimately it approaches a constant limiting value. If the current is increased still further the gradient at first remains constant, and then generally, as the current increases, it again begins to sink. Tables showing the potential gradient between two sounds are given for different pressures and currents. A. E. G.

1486. *Phosphorescence observed on the Glass of Vacuum Tubes when the Pressure is not very low.* **J. J. Thomson.** (Cambridge Phil. Soc., Proc. 15. p. 482, June 14, 1910.)—If an electric discharge is sent through a vessel from which the air is gradually exhausted, at a certain stage of the exhaustion the whole of the walls of the tube will be found to be phosphorescent. This phosphorescence is of quite a different colour from that produced by the kathode rays, and occurs at a much higher pressure; the pressures at which it is brightest vary with the dimensions of the vessel and with the gas inside it, but they are of the order of 1 mm. of mercury. The colour of the phosphorescence with soft soda glass is an olive-green; with lead glass it begins by being greenish but gets blue as the pressure diminishes. The following experiment indicates that the cause of the phosphorescence is ultra-violet light produced by the electric discharge. A large vessel is divided into two parts, A and B, separated by an opaque screen which is perforated with a long narrow channel, so that if any light is produced in A it will enter B as a fine pencil. The discharge is sent through A, and when the stage is reached at which the walls of A phosphoresce, the place where a pencil going through the channel strikes the walls of B becomes phosphorescent with a well-defined spot which can be made more brilliant by placing a little powdered willemite on the glass. Glass is found to be fairly opaque to these rays, although an appreciable phosphorescence is produced by rays which have passed through a cover-slip, and a pencil can even be detected after it has passed through the walls of the vacuum tube. Quartz is much more transparent to the pencil than glass, and white fluorite than quartz. The refraction of the pencil by the fluorite is quite marked. A. E. G.

1487. *A Glow Phenomenon in Vacuum Bulbs.* **M. Kinoshita** and **R. Ichinohe.** (Coll. Sci. and Engin., Mem. Kyōtō, 2. 6. pp. 171–186, 1910.)—If a p.d. be applied between a hot filament and a cold one, then, when this p.d. attains a certain value a blue glow begins to appear in the bulb. The luminosity of this glow is not the same throughout the bulb, but is feeble near the walls. Experiments with Pt filaments did not show any glow; with carbon, tungsten, and tantalum filaments, however, the glow could be examined. The value of the heating current at which the glow begins to become visible varies with the air pressure inside the bulb, and also with the p.d. If the heating current be raised above a certain value the glow begins to diminish in intensity; this diminution in intensity occurs very suddenly on the heating current attaining the critical value. The critical current differs according to the pressure and applied p.d., becoming larger as the pressure or initial p.d. is increased. When a suitable p.d. is initially applied, if the heating current is raised above its critical value and then lowered, the features of the variations of the space current and of the "effective" p.d. are different in the rising and falling process. In fact the variations are each followed by a certain hysteresis effect. The above phenomena may be explained as follows: When the heating current is sufficiently raised a copious emission of negative corpuscles takes place from the hot filament. Provided the pressure within the bulb is reduced sufficiently, and the effective p.d. is sufficiently increased, the emitted corpuscles move through the residual gas with very high velocities, and are consequently accompanied by intense kinetic energy, so that the atoms of the latter are broken down into ions in consequence of the bombardments from the corpuscles. Thus, in almost the whole region within the bulb ionisation occurs. A very simple explanation of the glow may then be given on the hypothesis that the recombination of ions gives rise to the luminosity. The intermittent glows arise as the result of the hysteresis of the effective p.d. and of the heating current. If the heating current be raised towards its critical value, when that value is reached the voltage becomes so reduced that the glow can no longer be sustained. The space resistance now increases and the voltage recovers its former value, thus causing the glow again to appear. A. E. G.

1488. *Aureoles observed around Conductors with High Tensions.* **R. P Schaffers.** (Annal. Soc. Sci. de Bruxelles, 84. 3 and 4. pp. 237–241, 1910.)—A preliminary theoretical paper based upon some discharge potentials quoted by A. R. Garnier [Abstract No. 162B (1910)]. From theoretical considerations it appears that (1) for a given wire the discharge by aureole always commences at the same value of the field, whatever may be its distance from neighbouring wires; (2) the fall of potential for the first ½ mm. in the neighbourhood of the wire is always the same for a given wire, at the instant of establishing the aureole; (3) the field and fall of potential in the first ½ mm. are independent of the diam. of the wire. These conclusions are to be tested by experiments with wires placed in a coaxial cylinder. Up to the present these experiments indicate that the field at the surface of the wire is not independent of the radius of the wire, thus upsetting the third provisional conclusion. A. E. G.

1489. *Unilateral Conductivity in a Fleming Oscillation Valve.* **R. Ichinohe and M. Kinoshita.** (Coll. Sci. and Engin., Mem. Kyōtō, 2. 4. pp. 107–119, 1910.)—An account of experiments with a Fleming oscillation valve, the object being to find out the relation between the current-voltage curve and the heating current, for different degrees of vacuum and for different kinds of filament. It is noticeable that the values for the space current are all much larger in the case of the Ta filament than with the other filaments (80×10^{-6} amp. as a maximum as compared with $44{\cdot}5 \times 10^{-6}$ for the tungsten, and 80×10^{-6} and 49×10^{-6} respectively for the Bergmann and Fulgura filaments). The working of such bulbs on the steep part of the curve as suggested by Fleming [Abstract No. 714B (1909)], is here somewhat curiously attributed to T. Mizuno. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1490. *Selenium Cells of High Sensibility.* **F. C. Brown.** (Phys. Zeitschr. 11. pp. 481–482, June 1, 1910.)—The author has prepared a form of selenium which is extremely sensitive to light, by mixing 10 parts of amorphous Se with one part of the red crystalline, form into a paste with ether; the ether is then allowed to evaporate and the mixture is heated for five hours at 170° C. A cell made from Se prepared in this way was found to show, at 8° C., a decrease of resistance to 1/800 of its original value on exposure to light; at 89° the resistance ratio is only 1/80. Such a cell is, however, of no practical value. (Ibid. pp. 482–483, June 1, 1910.)—A new, but unstable, modification of Se has been obtained which has a conductivity about 10^6 times that of the ordinary form; its resistance *increases* slightly on exposure to light. The mode of preparation employed is not described. L. H. W.

1491. *Thermoelectric Properties of some Minerals.* **M. Kimura, K. Yamamoto, and R. Ichinohe.** (Coll. Sci. and Engin., Mem. Kyōtō, 2. 4. pp. 59–61, 1910.)—The author gives a table showing the order which is occupied by 27 different minerals and metals in the thermoelectric series. The results are only very rough, having been obtained by heating the junction of two minerals by means of a red-hot piece of glass. The highest position is occupied by zincite, molybdenite coming next, galena sixth, Bi tenth, iron pyrites seventeenth, and tellurium last. L. H. W.

1492. *Unilateral Conductivity of Minerals in Contact.* **M. Kimura and K. Yamamoto.** (Coll. Sci. and Engin., Mem. Kyōtō, 2. 4. pp. 63–82, 1910.)—Tables and curves are given showing the relation between the p.d. applied and the current passing in the two directions for contacts between zincite and the following other substances: Te, copper pyrites, Bi, Pd, enargite, covelline, bornite, Pt, galena, niccolite; also others showing the effect of mechanical pressure at the contact upon the current passing. In general it is found that the power of rectification diminishes with increasing pressure, especially in the case of substances 2, 6 and 7. L. H. W.

1493. *Dielectric Behaviour of Melted Vaseline.* **L. Malclès.** (Comptes Rendus, 151. pp. 63–65, July 4, 1910.)—The paper is a continuation of the author's previous work on after-effect in solid and liquid dielectrics [see Abstracts Nos. 1057 (1907), 460 (1908)]. A condenser made with a cell of insulating material, in which the vaseline can be placed, is connected with one pair of quadrants of an electrometer and balanced against an adjustable condenser. The condensers are charged and the balance made, and any after-effect is shown by a deflection of the electrometer needle. With vaseline in the ordinary semi-fluid state there is no after-effect, indicating that in this state vaseline is a perfect insulator (with dielectric constant 1·97). When the cell between the condenser is filled with liquid vaseline, and the vaseline allowed to cool and solidify, anomalous effects are observed, which the author explains by assuming that vaseline acts as a medium containing free ions, whose mobility is zero in the semi-fluid state but observable in the liquid state. E. M.

1494. *Methods of measuring the Dielectric Coefficient.* **P. Floquet.** (Comptes Rendus, 151. pp. 545–548, Sept. 12, 1910.)—The different methods employed in practice for measuring the dielectric coefficient often give discordant results. The reason is due to the fact that the formulæ used are deduced on the supposition that the dielectric is "perfect." Malclès has recently shown that paraffin extracted from ozokerite when used as a dielectric does not show the phenomenon of residual discharge and has no appreciable conductivity. The author has used paraffin to test whether when its dielectric coefficient is found by different methods the results are concordant. Although the measures were made with a constant applied p.d. yet different numbers were sometimes obtained. When the force of attraction on a lump of paraffin hung in an electrostatic field was measured and the dielectric coefficient λ was deduced, it was found that the result depended on the amount of the atmospheric ionisation. When alternating currents of frequency 50 were employed the same number was always obtained for λ. The values obtained by finding the ratio of the velocities of Hertzian waves in paraffin and in air also gave the same value of λ. A. R.

1495. *Effect of Moisture upon the Electric Conductivity of Soils.* **R. O. E. Davis.** (Amer. Electrochem. Soc., Trans. 17. pp. 391–403, 1910.)—The results of conductivity measurements made with various kinds of soil are given in tables and curves which show the dependence on water-content and the influence of salts in solution. Typical values are: Quartz sand, loam, clay, and sand, all above 35,600 ohms per cm./cm.^2 when dry; when wet, quartz sand 4281, loam 1483–2018, clay 638–3151 ohms per cm./cm.^2

L. H. W.

1496. *Conduction of Electricity through Solid Silver Chloride.* **M. Le Blanc and F. Kerschbaum.** (Zeitschr. Elektrochem. 16. pp. 680–681, Aug. 15, 1910.)—The authors have previously called attention to the behaviour of solid silver chloride when subjected to direct current [see Abstract No. 727 (1910)]. They now find that the apparently abnormal increase in conductivity that occurs during passage of the current is due to the formation of fine silver threads which conduct metallically. A. F.

1497. *Theory of Quadrant Electrometer.* **R. Beattie.** (Electrician, 65. pp. 729–733, Aug. 12, 1910.)—An attempt is made to reduce the theory as far as possible to its purely physical elements, and to present it in its most elementary form. The controlling and deflecting couples are considered and determined, and by equating these the deflection θ is expressed by $\theta = [K_3V/(K_1 \pm K_2V^2)](v_1 - v_2)$, where K_1, K_2, and K_3 are constants and V, v_1, and v_2 the potentials of needle and quadrants respectively. The same equation gives the sensibility $\theta/(v_1 - v_2)$, and sensibility curves are drawn for the ordinary quadrant electrometer and the string electrometer. A comparison of the electrometer with the moving-coil alternating-current galvanometer is also made, the sensibility of the latter instrument being expressed by a similar equation to the one given. **D. Robertson.** (Ibid. pp. 781–782, Aug. 19, 1910.)—A discussion of Beattie's paper, in which, as well as in the usual formulæ, the expression of the sensibility in terms of the *absolute* potential of the needle is objected to. The forces acting in an electrometer do not depend on the absolute potential of the vane by itself, but on the difference between that potential and that of the quadrants. A sensibility equation is then worked out in terms of the rates of variation with θ of the capacities concerned. **R. Beattie.** (Ibid. pp. 821–822, Aug. 26; 910–911, Sept. 9, and pp. 1034–1035, Sept. 30, 1910.)—Beattie suggests that Robertson has made a mistake in working out his original equations, as the term V_1 is absent from the denominator. The use of the term "controlling couple" is upheld.

G. E. A.

1498. *The Action of an Induction Coil.* **J. K. A. Wertheim-Salomonson.** (Phys. Zeitschr. 11. pp. 538–543, June 15, 1910.)—A study was made of the occurrences following the break in an induction apparatus and especially the relation between the curves of the primary current given by the oscillograph and the observed vibrations. The Duddell high-frequency oscillograph (10,000 double vibrations per sec.) was used. The curves obtained are reproduced in the paper, and differential equations representing the mode of action of the induction apparatus are also given. When the coil was used with the gas interrupter, curves were obtained differing from those with the alcohol or petroleum interrupter. Whilst the latter showed only few peculiarities, those observed in the case of the first were very numerous. The curves indicate that the current rises first in a straight line after starting, and especially at first numerous small oscillations occur. At the stoppage of the current a series of extraordinarily rapid oscillations sets in. These vibrations fall into two groups which are partially superposed; a first group of very quick vibrations, and a second of relatively slow vibrations into which the first group gradually passes over. When the capacity of the primary condenser was increased or diminished the frequency of these two latter groups changed, whilst the frequency of the vibrations in the rising portion of the curve remained unchanged. On a change of the capacity of the secondary the frequency of all the vibrations was altered. A fairly accurate determination of the special frequency of the secondary coil was obtained, and thus from a knowledge of the self-induction—in the actual case 515 henrys—an accurate measurement of the actual capacity of this coil. With a frequency of 1900 and self-induction of 515 henrys the capacity is thus expressed: $C_2 = 10^6/4\pi^2 \times (1900)^2 \times 515 = 13{\cdot}6 \times 10^{-6}$ mfd. This number is ten times greater than that given by B. Walter and 45 times smaller than the one given by Colley. Walter's number is determined by the directly observed vibrations, whilst in the author's work a correction is brought in whereby a greater approximation to the actually existing magnitude is attained. J. J. S.

1499. *Double Oscillograph for Lecture Demonstration.* **G. Sartori.** (N. Cimento, 19. pp. 390–396, June, 1910.)—A modification of the double oscillograph described by Piola [Abstract No. 1096 (1909)], and consisting of two independent oscillographs having their axes at right angles and placed in two parallel planes. A small square mirror occupies the centre of the apparatus and is attached to the two vibrating spirals by means of silk threads. One of the oscillographs being made adjustable by a micrometer screw allows the necessary tension to be given to the silk threads. A ray of light is projected on to the mirror, and the reflected ray is received upon a screen. Photographs are reproduced of designs reflected on the screen with this apparatus, showing the composition of two large orthogonal vectors of equal period, but differing phase and amplitude, and under different conditions as to presence or absence of an iron core, &c. The application of the apparatus to the demonstration and study of hysteresis is also shown. W. H. Si.

1500. *Electrostatic Potential-multiplier and its Uses.* **C. and P. Habicht.** (Phys. Zeitschr. 11. pp. 532–535, June 15, 1910. Electrical World, 56. pp. 167–168, July, 21, 1910. Abstract.)—Following up Einstein's idea [see Abstract No. 2037 (1908)] the authors have constructed a potential multiplier on a somewhat different plan. The apparatus consists of six plate condensers, each formed of two fixed plates with one revoluble plate in between; each plate only occupies a sector of one-sixth of the circle. The condensers are all connected up in series and the movable plates are all mounted on a single central spindle which is driven by a suitable motor. Contact brushes are so arranged that each condenser is first charged, and then, when its movable segment is exactly between the two fixed ones, the applied voltage is cut off: as the charge given remains the same but the capacity decreases as the movable segment passes out from between the fixed plates, the potential will rise in accordance with the well-known relation between charge, capacity, and potential. In the experimental apparatus the ratio of transformation (increase of potential) for the six steps was 8·5, 72, 620, 5200, 45,000, 360,000 respectively. So long as the speed of rotation remained over 1500 r.p.m., variation of speed had no influence on the transformation ratio: the voltage variation observed was only 0·0003 volt. The advantages which such an apparatus possesses are pointed out. One advantage is the small capacity (10 cm. about). It is possible, for instance, with a single electrostatic voltmeter and the multiplier, to measure at the various terminals of the different stages of the apparatus the following range of voltages:—

Stage 6......	0·0005 to 0·0027 volt	Stage 3......	0·170 to 1·60 volts
„ 5......	0·0023 „ 0·022 „	„ 2......	1·40 „ 13 „
„ 4......	0·020 „ 0·19 „	„ 1......	12 „ 110 „

Direct 100 to 1000 volts.

L. H. W.

ALTERNATING CURRENTS AND MAGNETISM.

1501. *Distribution of Induced Magnetism in an Elliptic Toroid of Soft Iron.* **T. Takamine, T. Ōba** and **Y. Matsumoto.** (Mathematico-Physical Soc., Tōkyō, Proc. 5. 17. pp. 303–308, June, 1910.)—Ballistic experiments were made on an elliptic toroid of annealed soft iron to determine the distribution of the magnetism induced by applied fields of 5, 10, 20, 50 and 130 c.g.s. units. The dimensions of the specimen were—axes of the elliptic section, 10 and 0·2 cm.; diam. of the circular section at end, 1·6 cm. For this dimension-ratio it is found that the distribution is nearly independent of the intensity of magnetisation, whereas with a cylindrical bar the polar separation increases considerably with the applied field. A. D. R.

1502. *Demagnetising Factors for Iron Rods.* **C. L. B. Shuddemagen.** (Phys. Rev. 31. pp. 165–169, Aug., 1910.)—When an iron rod is subjected to a magnetic field H_0 in a long solenoid it becomes magnetised, and its own magnetism gives rise to a field H_m which is everywhere superposed upon the original field H_0 due to a current in the solenoid itself. The vector addition of these two fields gives the resultant magnetising field H, which controls the actual intensity of magnetisation I at every point of the iron rod. Then $I = kH$ and $B = 4\pi I + H = (4\pi k + 1) H = \mu H$. Also near the middle of the rod $H = H_0 - H_m$ nearly. Now, if the iron rod be magnetised continuously from neutrality to any state in which the intensity of magnetisation in the middle is I, then H_m will depend on I and we have $H_m = NI$, where N is a demagnetising factor and is such a function of I as to make the equation true. It was formerly thought that N was constant and depended only on the ratio of the length to the diam. of the cylindrical iron rod, or on $m = L/D$. But it was shown by Benedicks and the author [see Abstract No. 1916 (1907)] that N is only approximately constant in the interval between $I = 100$ to $I = 800$. Beyond this it decreases rapidly to a minimum value as the magnetisation approaches saturation. Moreover, N varies also for different absolute values of D, the diam. of the iron rod, being somewhat less for thick rods than for the thin ones when L/D remains constant. The rods tried varied from 0·3175 cm. to 1·905 cm. diam. Two solenoids were used in which the lengths were 207·7 cm. and 485·3 cm., and for which $H_0 = 20·5 \times$ (no. of amps.) and $H_0 = 27·064 \times$ (no. of amps.) respectively. The magnetic induction in the middle part of the rod was found by a secondary coil there in connection with a galvanometer used ballistically. One demagnetising factor N has already been noticed, another K, is easier to use in conjunction with the ballistic method, their relation is given by—

$$H = H_0 - H_m = H_0 - NI = H_0 - KB.$$

Using the method of steps, the values of N and K were as in the following table. With the method of reversals slightly lower values were found.

m = L/D.	Values of N.		Values of K.	
	D = 0·32 cm.	D = 0·6 to 2 cm.	D = 0·32 cm.	D = 0·6 to 2 cm.
10	0·220	0·204	0·0175	0·0162
15	0·117	0·106	0·0093	0·0084
20	0·074	0·0672	0·0059	0·00535
25	0·0515	0·0467	0·0041	0·00372
30	0·0382	0·0344	0·00304	0·00274
35	0·0295	0·0264	0·00235	0·00210
40	0·0234	0·0211	0·00186	0·00168
45	0·0191	0·0172	0·00152	0·00137
50	0·0160	0·0144	0·00127	0·00115
60	0·0115	0·0104	0·00091	0·00088
70	0·0087	0·00795	0·00069	0·00063
80	0·0069	0·00625	0·00055	0·00050
90	0·0056	0·00507	0.000445	0·000404
100	0·0046	0·00420	0·000366	0·000334
125	0·0031	0·00280	0·000247	0·000223
150	0·00222	0·00204	0·000177	0·000162
175	0·00166	0·00154	0·000132	0·000122
200	0·00130	0·00120	0·000103	0·000096

E. H. B

1503. *Magnetisation in an Alternating Field.* **C. E. Guye** and **Mlle. Karpowa.** (Le Radium, 7. p. 241, Aug., 1910. Paper read before the Congrès Internat. de Radiologie et d'Électricité, Brussels, Sept., 1910.)—Investigation was made of the variation of magnetic permeability of a body subjected to an alternating field of high frequency. The current from an alternator passed through an ammeter and a primary circuit wound round an iron wire 0·04 mm. in diam. A secondary coil of manganin was connected to a Wulf electrometer. This arrangement practically eliminates eddy currents, and also secondary currents with their consequent magnetising reaction. It is found that the magnetisation curve is not sensibly altered by variation of the frequency from 300 to 1200 ∿ per min. A. D. R.

1504. *Earth Currents.* **B. Brunhes.** (Comptes Rendus, 151. pp. 409–411, Aug. 1, 1910.)—The present note is in continuation of a former article [Abstract No. 1620 (1909)] and deals with the variations of telluric currents at different depths below the earth's surface. The observations were made at the Messeix mines at Puy-de-Dôme, at ground-level, 54 m. and 150 m.

depth; the deviations were photographically recorded. The results show that between 54 m. and 150 m. there is a stratum having the same potential as the surface. Between 0 m. and 54 m. the p.d. was about 40–50 millivolts.
C. P. B.

1505. *Variations in Terrestrial Magnetism.* **E. Leyst.** (Soc. Imp. Nat. Moscou, Bull. 23. pp. 140–389, 1909.)—This paper deals with the secular, annual, and diurnal variations in terrestrial magnetism, and with the part played by the earth's atmosphere in the diurnal change. Extensive tables are given of magnetic observations made during the years 1878 to 1906 at several Russian stations and also at Greenwich and Potsdam Observatories. The accuracy of these data is discussed especially in regard to the effects introduced by the change from time to time to newer forms of recording apparatus. The results are then grouped so as to separate the different periodic changes, and the following are the more important general conclusions thus obtained. The secular variation of terrestrial magnetism, and in particular of the declination, is closely dependent on the solar activity as indicated by the number of sun-spots. At Katharinenburg alone out of five observatories has the secular change in magnetic declination its greatest value during sun-spot minima, but in this instance there is comparatively little change at all in the rate of secular variation. The annual variation in magnetism, unlike the secular and diurnal, does not show a simple relationship to solar activity. At Pawlowsk, for example, magnetic storms are in general most severe in the year preceding sun-spot maxima, and the quietest period is after sun-spot minima when the spots are increasing. The year of maximum sun-spots shows a smaller variation in terrestrial magnetism than either the preceding or the following year. The intensity, too, as a rule undergoes greatest change in years of sun-spot minima. A large amount of data is given to exhibit a connection between the diurnal variation in magnetism and changes in atmospheric pressure. While there is apparently clear evidence of some such connection, it is certainly not one of cause and effect, and other concomitant phenomena are probably concerned. The apparent relationship cannot be explained by atmospheric changes altering slightly the gravitational action on the delicate magnetic instruments.
A. D. R.

ELECTROPHYSIOLOGY AND ELECTROTHERAPEUTICS.

1506. *Sterilisation of Liquids by Light of very short Wave-length.* **T. Lyman.** (Nature, 84. p. 71, July 21, 1910.)—Some attempts have been made to sterilise liquids by the Schumann rays. The author notes, however, that a column of distilled water absorbs all rays of a shorter wave-length than $\lambda = 1792$. As a vacuum tube containing mercury gives out no rays between $\lambda = 2000$ and $\lambda = 1650$ and a strong spectrum between $\lambda = 1650$ and $\lambda = 1030$, it is evident that any action must be limited to an exceedingly thin layer of water. A mercury tube has also been used in this connection, but this source gives no rays of shorter wave-length than $\lambda = 1850$. E. C. C. B.

1507. *Quantitative Measurements of the Conversion of Kathode Rays into Röntgen Rays by Antikathodes of different Metals.* **J. H. Gardiner.** (Röntgen Soc., Journ. 6. pp. 88–93; Discussion, pp. 93–97, July, 1910.)—The photographic method is employed. With the apparatus used it is found that the point of max. intensity of the rays is about 80° above the plane of the antikathode, and the plate-holder was, therefore, fixed in this position with regard to the bulb. The density measurements are expressed in the usual opacity logarithms (log I/T), and are proportional to the mass of silver per sq. cm. of film. The following table shows the results obtained with the various metals used:—

Antikathode.	Atomic Weight.	Röntgen-ray Efficiency.	Antikathode.	Atomic Weight.	Röntgen-ray Efficiency.
Carbon	12	60·4	Tantalum	181	90·5
Aluminium	27	65·7	*Platinum*	*195*	*100*
Iron	56	40·4	Gold	197	86·1
Nickel	59	42·4	Uranium	238·5	92·0
Silver	108	66·4			

In the *discussion*, **G. W. C. Kaye** referred to some experiments in which he found, when using measurements by the ionisation method to test the properties of different metal antikathodes, that if the rays fired directly through the bulbs are measured, then there is no sort of relation between the atomic weights of the antikathodes and the intensities of the emitted Röntgen rays; yet when a screen of sufficient thickness is used the intensity of the rays is found to be roughly proportional to the atomic weight of the metal forming the antikathode. It is possible that the results obtained by the author are affected by the secondary radiation produced, and Kaye considers this may be the cause of the relatively low efficiency of Fe and Ni as Röntgen-ray producers. A. E. G.

REFERENCES.

1508. *Fields of Moving Charge by Relativity Principle.* **K. Tamaki.** (Coll. Sci. and Engin., Mem. Kyōtō, 2. 6. pp. 151–158, 1910.)—The classic solution of the problem of the electromagnetic field accompanying a moving electric point-charge being due to Heaviside, and the modern methods involving the use of vectors or the so-called retarded scalar and vector potential, the present author here gives a simple solution in which the principle of relativity is applied to the Maxwell-Hertz equations. E. H. B.

1509. *Relativity Principle applied to Electromagnetic Problems.* **T. Mizuno.** (Coll. Sci. and Engin., Mem. Kyōtō, 2. 6. pp. 159–170, 1910.)—Einstein's theory relating to the principle of relativity is here applied to the solution of the electromagnetic fields due to (1) a moving magnetic pole, (2) a moving electric doublet, and (3) a moving uniformly magnetised sphere. E. H. B.

1510. *The Diurnal and Annual Variation of the Atmospheric Electrical Dissipation.* **C. Negro.** (Phys. Zeitschr. 11. pp. 405–407, May 1, 1910. From the Italian.)

1511. *Heat developed during the Absorption of Electrons by Platinum.* **O. W. Richardson** and **H. L. Cooke.** (Phil. Mag 20. pp. 173–206, July, 1910.)—The full paper corresponding to Abstract No. 408 (1910)].

1512. *Voltmeter for High Pressures.* **A. Tschernyscheff.** (Phys. Zeitschr. 11. pp. 445–448, May 15, 1910.)—An illustrated description is given of the author's arrangement of an electrometer working in compressed air. [See Abstract No. 488B (1910).]

1513. *Telephone Receivers without Cores: Speaking Iron.* **E. Kosack.** (Elektrotechn. Zeitschr. 30. pp. 567–573, June 17, 1909. Elect. Engin. 44. pp. 10–11, July 2, 1909. Abstract.)—An account of experiments similar to those of Peukert [Abstract No. 288 (1909)]. Various forms of telephone receiver without magnetic core are tried. L. H. W.

1514. *Lines of Magnetisation of a Spherical Layer Magnetised by a Uniform Field.* **L. de La Rive.** (Journ. de Physique, 8. pp. 670–675, Sept., 1909, and 9. pp. 224–230, March, 1910. Paper read before the Soc. helvétique des Sciences naturelles, Glaris, 1908.)

1515. *Variations in the Magnetic Properties of Iron with Temperature.* **C. Maurain.** (Annal. Chim. Phys. 20. pp. 353–389, July, 1910.)—The full paper corresponding to Abstract No. 732 (1910).

1516. *Thermomagnetic Properties of Elements.* **K. Honda.** (Ann. d. Physik, 32. 5. pp. 1027–1063, July 8, 1910.)—The full paper corresponding to Abstract No. 736 (1910).

1517. *Electron Theory of Magnetism.* **R. Gans.** (Gesell. Wiss. Göttingen, Nachr., Math. Phys. Klasse, 3. pp. 197–273, 1910.)—Mathematical. An application of the electron theory to explain the magnetic behaviour of such substances as pyrrhotine, and iron electrolytically deposited in a magnetic field. A. D. R.

1518. *Russian Magnetic Survey.* **D. A. Smirnov.** (Acad. Sci. St. Pétersbourg, Bull. 11. pp. 841–846, June 15, 1910.)—Magnetic elements are given for ninety stations lying on the line from Warsaw to Vladivostok. The observations were made in 1901, 1904, and 1909, and the secular variations during the intervals are given for several stations. A. D. R.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1519. *Absorption of Gases by Charcoal.* **I. F. Homfray.** (Roy. Soc., Proc. Ser. A. 84. pp. 99–106, July 8, 1910.)—A series of measurements of the absorption of various gases by charcoal were made, with a view to determining, firstly, the volume of different gases absorbed under different conditions of temperature and pressure; secondly, to deduce a generalisation therefrom, if possible, which should bring it into line with other data; and thirdly, to endeavour to throw light on the nature of this phenomenon. The apparatus used consisted of a gas thermometer, the bulb of which contained about 8 gm. of purified cocoanut charcoal, and was connected with a mercury pump and gas burette. Successive volumes of gas were admitted and the pressures (up to 800 mm. of mercury) read, at different temperatures ranging from boiling aniline to that of liquid air. The results obtained agree best with the theory that the phenomenon is one of solution. The author discusses the alternative theories of chemical combination and adsorption. The charcoal is classed as a highly supercooled fluid. When, however, the amorphous charcoal is converted into crystalline graphite it entirely loses its absorptive power. F. J. B.

1520. *Density of Radium Emanation.* **W. Ramsay** and **R. W. Gray.** (Engineering, 90. pp. 422–423, Sept. 23, 1910. Abstract of paper read before the British Assoc. at Sheffield. Comptes Rendus, 151. pp. 126–128, July 11, 1910. Annal. Chim. Phys. 21. pp. 145–148, Oct., 1910.)—The paper deals with a determination of the atomic weight of RaEm by direct weighing. The weight of emanation at the disposal of the authors was of the order 700 millionths of a mgm. so that a micro-balance [Abstract No. 1983 (1909)] had to be used. The emanation was carefully purified and sealed off in a thin glass tube which was afterwards broken and the difference in weight due to the escape of the emanation observed; and from the previously determined volume the density could be calculated. Five experiments were made giving values for the molecular weight ranging from 216 to 227 with a mean of 220. The authors conclude that RaEm is the second member of the series of inactive gases after xenon, and therefore propose to rename it "Niton" so as to show its connection with this series. E. M.

1521. *Slow Precipitation of Radium Sulphate.* **L. Kolowrat.** (Le Radium, 7. pp. 157–159, June, 1910.)—Previous observations by Mme. Curie [see Abstract No. 921 (1910)] have shown that the emanating power of an acid solution of a radium salt freshly precipitated by H_2SO_4 diminishes with time. The present paper deals with an investigation as to whether this peculiarity is a purely chemical phenomenon or is due to the separation of some product intermediate between Ra and RaEm. A dilute solution of $RaCl_2$ was treated with several drops of H_2SO_4 and filtered, and the filtrate placed in an emanation "bubbler" [see Abstract No. 921 (1910)]. The rate of disengagement of emanation was measured and found to gradually fall to nearly half its original value in about a month, while on the application of heat the rate of disengagement of emanation increased. The author explains this, and other experiments described in the paper, by assuming that the $RaSO_4$ remains partly in solution but gradually becomes precipitated and no longer gives up its emanation. Under the action of heat, part of the precipitate redissolves and gives off the whole of the emanation accumulated since its precipitation. [See also Abstract 1178 (1910).] E. M.

1522. *Demonstrating the Absorption of Colourless Solutions in the Ultra-violet.* **C. Schall.** (Zeitschr. f. physikal. Unterricht, 21. pp. 389–390, 1908.) —The author's paper sensitive to ultra-violet light [see Abstracts Nos. 809 (1909), 1348 (1910)] may be employed to demonstrate differences of absorption in the ultra-violet. A trough having its front and back made of transparent quartz, is partly filled with alcohol and is placed, together with a second (empty) trough made of glass, in front of a sheet of the sensitive paper; the troughs and paper are then exposed to the light from an Heraeus mercury lamp 4 cm. away. White silhouettes of the troughs on a blue background are obtained in a few minutes, the paper being coloured solely where the ultra-violet rays had only to pass through air, alcohol, or quartz. If a concentrated solution of naphthalene in alcohol is placed in the quartz trough instead of alcohol alone, a completely white image of the trough is obtained, since naphthalene absorbs ultra-violet rays. L. H. W.

1523. *Vapour Pressure of the Granules of Solid Substances.* **P. N. Pawlow.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. pp. 679–684, 1909.)—The author has investigated the relation between the vapour pressure and size of solid granules by placing small granules of various substances in closed chambers, and observing from time to time the changes in their magnitudes, the temperature of the surrounding air being 13–15°. The compounds examined were diphenylmethane, triphenylmethane, iodoform, dibenzyl, menthol, salol, guaiacol, and azoxyphenetole. In the case of diphenylmethane, for example, the granules employed were, at the least, 2μ in diam. In 2 days' time these small granules diminished in number, and many as large as 30μ appeared. After 6 days, very few granules less than 7μ in size were found, and after a month granules less than 14μ in diam. were rare. In part the crystals were collected in heaps along the edges of the chamber, and all the crystals exhibited rounded angles. Assuming that the pressure of saturated vapour follows the laws of ideal gases, the Clausius-Clapeyron equation for the evaporation of solids leads to the expression $d(\log p)/dT = Q/2T^2$, where p is the pressure of the saturated vapour, Q the molecular heat of evaporation, and T the absolute temperature. From this expression the author deduces the equation $p_2\pi_1/\pi_2 p_1 < 1$, where p_1 and p_2 are the vapour pressures of the finest granules, and π_1 and π_2 the vapour pressures of the coarse granules at two neighbouring temperatures. This inequality determines the course of the vapour-pressure curves for the granules considered, and renders it evident that, in the general case, these curves will intersect. From the author's previous deductions (Zeitschr. Phys. Chem. 65. p. 545, 1909) it follows that, if the free surface energy is independent of the radius of the granule, the vapour-pressure curves will meet at an infinite temperature. If, however, the free surface energy is a function of the granule-radius, the curves will meet at some finite temperature. [See also Abstract No. 1148 (1909).] T. H. P.

1524. *Relations between the Surface Modifications of Solid Crystalline Substances. Nature of Liquid Crystals.* **P. N. Pawlow.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. pp. 685–688, 1909.)—Corresponding with the two types of vapour-pressure curves [see preceding Abstract], two classes of surface modifications may be distinguished. With substances of the first class, the point of intersection of the vapour-pressure curves lies above the melting-point, so that the transformation of one surface modification into the other cannot be observed. Such substances the author terms monotropic with respect to the transformation of their surface modifications. All substances will be monotropic which exhibit direct change of the solid crystals into the isotropic liquid. With substances of the second class, the vapour-pressure curves for the large and small granules meet at a temperature below that at which the substance is converted into isotropic liquid (m.p.), so that the surface modifications can, in this case, be converted one into the other at a temperature lower than the melting point; such substances are termed enantiotropic. Below this transformation temperature, the coarse-grained modification will be stable, whilst above it the stable modification will consist of the smallest crystalline individuals capable of existence. This aggregate of small crystals will form a liquid phase exhibiting surface tension and the other properties characteristic of liquids. To this class of enantiotropic substances must be referred that group of compounds which, on melting, are transformed into anisotropic liquids, that is, the so-called liquid crystals. The latter are hence not crystals, but consist of crystalline dust condensed to a liquid, in which, in some circumstances, the separate individuals may be regularly orientated. T. H. P.

1525. *The Sun as Heat Source in Chemical Experiments.* **A. Stock** and **H. Heynemann.** (Ber. Deut. Chem. Gesell. 42. pp. 2863–2866, 1909.)—If the substance to be heated be contained in an exhausted glass vessel, the heat can be concentrated upon the substance itself, so that a very highly refractory supporting vessel is not required. The authors describe the apparatus employed by them, a plano-convex lens of 40 cm. diam. and 50 cm. focal length being used to concentrate the sun's rays on to the substance which was itself placed in a magnesia crucible. Pieces of copper and cast-iron were melted almost instantly, whilst crystallised Si (melting-point 1450° C.) was melted in a few seconds. A thermo-junction supported at the centre of the flask gave a reading of 1030° C. *in vacuo*; a reading unexhausted indicated only 675° C. L. H. W.

1526. *Preparation and Investigation of Reguline Zirconium.* **L. Weiss** and **E. Neumann.** (Zeitschr. Anorg. Chem. 65. 3. pp. 248–278, 1910.)—After a brief review of previous attempts to prepare zirconium metal in the fused state, with special reference to Wedekind's experiments [Zeitschr. Angew. Chemie, and Abstract No. 919 (1909)], the authors describe their own work. In the first experiments, starting from potassium zirconium fluoride, amorphous zirconium of 98 per cent. purity was obtained by reduction with sodium. On using the powdered metal in moulds, without binding material, to make rods by means of high pressures (60 tons per cm.^{2}) applied to the powder, strong sticks of metal weighing 30 gm., 12 cm. long, 0·5 cm. thick, and 1 cm. wide were obtained. These sticks were good electrical conductors, the average resistance of such a stick being 118·6 ohms. When these sticks, however, were used for the fusion process in the electric vacuum furnace, they always burst at the place where they were held in the electrode holders. It was found impossible to prepare any quantity of fused metal in this way, although a few fused beads were obtained. The next attempts involved the production of crystallised Zr by reduction of the potassium zirconium fluoride with Al, with a view to driving off the Al in the vacuum furnace, Troost's method being followed.

From the zirconium-aluminium obtained (as thin flakes) sticks were prepared which were good conductors, and allowed of being filed. The sticks were placed in a vacuum furnace and an electric flame-arc was allowed to form between the ends, under a current of hydrogen. With currents of 40–45 amps. at 20–25 volts the ends of the sticks fused, and after some time molten metal fell off. In this way 2 to 3 gm. of fused metal was prepared of mean sp. gr. 5·66 and hardness 6·5, the content of Zr being 91·3 per cent. More satisfactory results were obtained by first heating the sticks for two hours in hydrogen; by this "fritting" they were brought to a condition in which they could be filed. The fritted sticks were then placed in a v. Bolton-type vacuum furnace. With an atmosphere of hydrogen the metal was only obtainable at very low pressures; with nitrogen, on the other hand, the metal (99·76–100 per cent. pure) was obtained at atmospheric pressure, using 60–80 amps. at 25 volts, though the process is preferably conducted under reduced pressure. *Physical Characteristics.*—The fused Zr is somewhat tarnished superficially, but broken pieces have a bright metallic lustre, the fractured surface looking like cast iron. The hardness lies between 7 and 8, quartz being scratched though topaz is not. The metal is very brittle; it is readily powdered into a mortar, flashes of light accompanying the crushing process. The sp. gr. at 18° is 6·40 (Wedekind, 6·4), while the unfused metal from Biermann has sp. gr. 5·17. The specific heat (mean) was found to be 0·0804; the atomic heat is thus 7·3164. The heat of combustion is 1958·7 cals. per gm. The concluding part of the work deals with the purely chemical properties. L. H. W.

1527. *Metallic Titanium.* **L. Weiss** and **H. Kaiser.** (Zeitschr. Anorg. Chem. 65. 4. pp. 345–402, 1910.)—The authors describe the methods of preparation and analysis of amorphous and cast titanium and of titanium "aluminides." A product prepared by fusing the amorphous metal was found to contain 97·41 per cent. Ti, and had the following constants: sp. gr. 5·174 at 19–20°, mean specific heat 0·1418, and heat of combustion 24·443 cals. per equivalent. Titanium melts at 2200–2400° C. T. H. P.

1528. *Preparation of Titanium.* **M. A. Hunter.** (Amer. Chem. Soc., Journ. 32. pp. 330–336, March, 1910. Chem. News, 101. pp. 282–284, May 20, 1910.)—Pure Ti cannot be obtained either by the classic method of Berzelius (1825), or by those of Wöhler and Deville and of Moissan. The author has, however, succeeded in obtaining a yield of pure Ti amounting to about 90 per cent. of the theoretical by reduction of titanium tetrachloride with sodium in an air-tight steel cylinder. The metal Ti resembles polished steel in appearance. When cold it is hard and brittle, but at a low red heat it is very malleable. Its sp. gr. is 4·50, and the melting-point lies between 1800 and 1850° C. L. H. W.

1529. *Magnetic Compounds of Manganese with Nitrogen.* **E. Wedekind** and **T. Veit.** (Ber. Deut. Chem. Gesell. 41. pp. 3769–3778, 1908.)—The authors have prepared three nitrides of manganese, Mn_3N_2, Mn_5N_2, and Mn_7N_2, and found that all three are magnetic, the magnetic properties increasing with increasing content of Mn; Mn_7N_2, shows some permanent magnetism. On heating metallic Mn in a current of hydrogen in the oxy-coal-gas flame, a product was obtained which possessed feeble magnetic properties, but appeared to be free from hydrogen; on heating this substance in oxygen the magnetic properties became stronger. Metallic Mn heated in oxygen at a red heat, yielded a non-magnetic product; after heating in the oxy-hydrogen flame, this became magnetic. L. H. W.

1530. *Metallic Nitrides and their Magnetic Properties.* **I. Shukoff.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. pp. 457–459, 1908.)—The author has investigated the absorption of nitrogen by finely-divided Mg, Ca, Al, Ti, V, Cr, Mn, Fe, Cu, Mo, and W. The metal was placed in a porcelain tube which was exhausted, connected with a nitrogen supply, and heated in an electric furnace. The tube was connected with a manometer, and the temperatures at which absorption of nitrogen by the metal commenced were measured by a pyrometer. Vanadium, Fe, Cu, and W do not absorb nitrogen at temperatures below 1250°, whilst Mo absorbs only traces. The rest of the metals named absorb nitrogen rapidly. The temperatures at which this absorption begins are as follows: Mg, 780–800°; Ca, 780–800°; Al, 800–825°; Ti, 900–925°; Cr, 800–820°; Mn, 850–875°. In no case does the metal melt, although in several instances the temperatures at which absorption of the gas apparently begins are considerably above the melting-points of the metals; it is probable that a slight amount of absorption proceeds at lower temperatures than those given above. The products formed consist, in the cases of Mg, Ca, and Al, of the definite compounds Mg_3N_2, Ca_3N_2, and AlN. Mn, absorbs 12 per cent.; Cr, 8 per cent.; and Ti, 21 per cent. of nitrogen; the products in these instances consisting either of solid solutions of nitrogen in the metals or of solutions of definite nitrogen compounds in excess of the various metals. The Mn product, containing 12 per cent. of nitrogen, exhibits magnetic properties almost as intense as those of iron, and the Cr and Ti products are also distinctly magnetic. T. H. P.

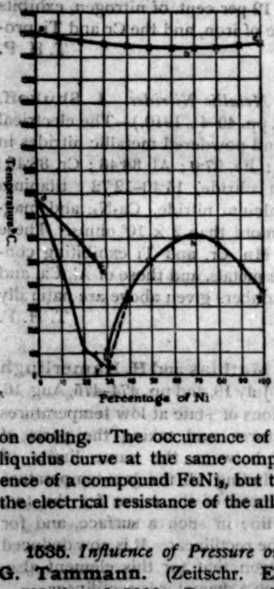
1531. *Electrical Conductivity of Certain Metallic Nitrides.* **I. Shukoff.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 42. pp. 40–41, 1910.)—The electrical conductivities of certain powdered metals and powdered metallic nitrides in reciprocal ohms per cm. cube are as follows: Fe, 27·0; Al, 88·46; Cr, 88·46; manganese nitride, 18·18–22·62; chromium nitride, 15·40–12·72; titanium nitride, 81·05. Aluminium nitride, AlN, calcium nitride, Ca_3N_2, and magnesium nitride, Mg_3N_2, show resistances of more than 2×10^6 ohms. These nitrides hence form two classes, those of Mn, Cr, and Ti exhibiting conductivities of the same order as those of pure metals, and those of Al, Ca, and Mg having very small conductivities. The numbers given above are naturally only of a qualitative character. T. H. P.

1532. *Rectilinear Diameter of Oxygen.* **E. Mathias and H. Kamerlingh Onnes.** (Comptes Rendus, 151. pp. 213–216, July 18, and pp. 474–475, Aug. 16, 1910.)—Representing by surfaces the equations of state at low temperatures of bodies having different critical temperatures, and taking the parts of these surfaces determined experimentally between the same limits of temperature, a surface may be obtained including all the low-temperature values experimentally determined. The diameter of the curve for the two densities of a substance is a characteristic line in such a surface, and for normal substances, has been already shown to be rectilinear. It is now deduced from determinations of the isotherms of oxygen, that for this element also, which has a very low critical temperature, such a diameter is rectilinear.

W. H. Sı.

1533. *Electrolytic Conductivity of Fluorescent Solutions.* **A. Rassenfosse.** (Bull. Acad. Roy. Belg. pp. 995–1107, 1909.)—According to the theory of de Heen, the conductivity of a fluorescent solution should depend on the light to which it is exposed. Experiments on solutions of fluorescein and eosin show that the conductivity is a maximum when they are submitted to the action of light which is absorbed by them, green in the case of fluorescein, and yellow in the case of eosin. Blank experiments on solutions of potassium chloride proved that the conductivity does not vary under the action of light of different colours, and also that the observed variation in the case of the fluorescent solutions is not a thermal effect. T. S. P.

1534. *Iron-Nickel System.* **R. Ruer** and **E. Schüz.** (Metallurgie, 7. pp. 415–420, July 8, 1910.)—The authors have re-investigated this system on account of discrepancies in the results of previous workers. Alloys were made by fusing together iron of 99·8 per cent. purity and nickel containing 0·19 per cent. carbon as only impurity in a magnesia-lined carbon crucible. Cooling curves of the alloys were taken, and the results plotted in the form of an equilibrium diagram which shows for the liquidus a continuous curve with a minimum at 70 per cent. Ni and a temperature of 1458° C. Since the cooling of Fe-Ni alloys is accompanied by polymorphic changes with corresponding changes in the permeability, an investigation of the variation of the magnetic permeability with concentration and temperature was undertaken, and the mean results are plotted as in the accompanying diagram. The results agree in general with those of Guillaume and Osmond; the alloys being divided into two classes, reversible (Ni-rich) and non-reversible (poor in Ni), according as the loss of magnetism on heating and its return on cooling occur at the same or widely differing temperatures. The dividing line appears to lie at about 27·5 per cent. Ni. In the diagram the line *ghi* represents the reversible change occurring in the Ni-rich alloy. There is very little temperature interval over which the change occurs in the alloys down to 40 per cent. Ni, but in the alloys containing 40 to 80 per cent. Ni the change takes place over a measurable range of temperature and the end of the change is indicated by the dotted line *kl*. In the Fe-rich alloys, the line *de* represents the temperature of loss of magnetism on heating and *df* its return on cooling. The occurrence of the maximum *h* and the minimum *b* on the liquidus curve at the same composition (70 per cent. Ni) points to the existence of a compound $FeNi_3$, but this was not confirmed by a determination of the electrical resistance of the alloys. F. C. A. H. L.



1535. *Influence of Pressure on the Electrolytic Conductivity of Solutions.* **G. Tammann.** (Zeitschr. Elektrochem. 16. pp. 592–599; Discussion, p. 599, Aug. 1, 1910. Paper read before the Deutsch. Bunsen-Gesell., Giessen, May, 1910.)—A summary of the results of the researches by Röntgen and others and by the author in conjunction with Bogojawlensky, Körber, and E. W. Schmidt [compare Abstract No. 1089 (1910)]. Although ionic friction and viscosity are not influenced in the same way by pressure, the two changes are interconnected. Water behaves abnormally with regard to pressure as in most other respects. The viscosity of water decreases at first with increasing pressure (it increases in the case of ether, benzol, &c.); since, however, the thermal expansion of water becomes more normal at higher pressures, the viscosity of water should also increase with the pressure at high pressures, and the viscosity curves should show a minimum. This minimum may be traced in the dependence of the viscosity of certain salt solutions upon their concentration. Thus the resistance of aqueous solutions decreases first as the pressure is raised and increases afterwards, while with other solvents the resistance increases steadily with raised pressure. The influence of pressure upon the resistance of aqueous solutions is greater for weak electrolytes than for strong electrolytes, while the opposite holds for alcoholic solutions. When an electrolyte is dissolved, a contraction of the solution is observed; this contraction is abnormally large in the case of water. Hence the influences of increased pressure and of increased temperature on the conductivity of pure water are very great; these influences are much less marked in ordinary distilled water. The influence of pressure on the degree of dissociation of aqueous solutions is such that the differences in the degrees of dissociation disappear more and more as the pressure is raised. In its dependence upon the concentration of a solution the pressure influence upon the conductivity is dependent upon the dissociation constant, and weak, strong, and intermediate electrolytes yield different, though similar, characteristic curves.—These pressure influences would, as **W. Nernst** remarked during the *discussion*, lead to the assumption of an electrolytic dissociation of water, if other reasons had not suggested it. H. B.

1536. *Special Bronzes*—I. *Lead Bronzes.* **F. Giolitti** and **M. Marantonio.** (Gazzetta Chim. Ital. 40. 1. pp. 51–77, 1910.)—With a view to obtaining information concerning the structure of the lead bronzes containing about 10 per cent. of Sn and 20 per cent. of Pb, which are used largely for antifriction purposes, the authors have investigated the ternary system Cu-Sn-Pb, limiting themselves to alloys containing less than 20 per cent. of Pb or 25 per cent. of Sn. Investigation of the binary system Cu-Pb shows that these metals form no definite compound, and that they are only incompletely miscible in the liquid state and not at all in the solid state; the eutectic point is practically coincident with the melting-point of Pb. In the ternary alloys the Sn is always present in the form of the copper compound, Cu_4Sn or Cu_3Sn, or a solid solution of these two. The results obtained with a number of alloys are fully discussed with the help of a space-diagram. As regards hardness, this is not modified appreciably in alloys containing less than 14 per cent. of Sn by the addition of Pb in any proportion less than about 10 per cent. This result differs from that obtained by Guillet (Étude Industrielle des alliages métalliques), who stated that the hardness of these ternary alloys diminishes rapidly with increase of the Pb-content when the latter exceeds 3 per cent., but remains constant when more than 7 per cent. of Pb is present; his investigations were, however, made on alloys containing also a small quantity of Zn, and were limited to 8·52–10·28 per cent. of Sn. For alloys containing more than 14 per cent. of Sn, especially when less than 5–6 per cent. of Pb is present, the hardness decreases rapidly as the proportion of Pb increases. This fact agrees with the microphotographic observation that in these alloys the free Pb is almost entirely collected in, and diminishes the hardness of, the β-solid solution, to which the hardness is mainly due. T. H. P.

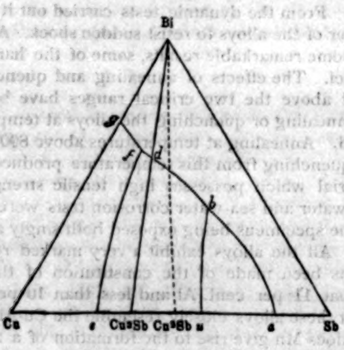
1537. *A Thorium-Nickel Alloy.* **E. Chauvenet.** (Bull. Acad. Roy. Belg. pp. 684–685, 1908.)—The author, using lithium instead of sodium as employed by Moissan and Hönigschmid [Abstract No. 1798 (1906)], was unable to obtain pure Th when heating in a nickel boat; an alloy of Th and Ni was, however, obtained in the form of grey flakes or a black powder, which corresponded with Th_2Ni on analysis. The powder is pyrophoric, and ignites spontaneously when powdered in a mortar. The alloy is non-magnetic. L. H. W.

1538. *Alloys of Platinum and Tin.* **N. I. Podkopjev.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. pp. 249–260, 1908.)—Platinum and tin react energetically with one another; much heat is developed, the temperature of the mass rising to 1840° C. The freezing-point curve consists of six branches. No solid solutions in Sn or Pt are formed by the six compounds. Photomicrographs of the alloys are given. [See also Doerinckel, Abstract No. 1600 (1907).] L. H. W.

1539. *Relation of Lithium to Sodium, Potassium, Tin, Cadmium, and Magnesium.* **G. Masing** and **G. Tammann.** (Zeitschr. Anorg. Chem. 67. 2. pp. 183–199, June 7, 1910.)—By using thermo-junctions of very thin wire, 0·05 to 0·2 mm. diam., combined with thin-walled protecting tubes, the authors have been able to take cooling-curves of 1·4 gm. of sodium and to work out a complete equilibrium diagram with 2 to 5 gm. of lithium. In this way the methods of thermal analysis can be applied to metals obtained pure only with great difficulty. The use of thermo-couples and protecting tubes of low heat-capacity results in very sharp and definite arrests in the cooling-curve. Lithium melts at 179° C., and its alloys with Na separate into two immiscible liquids, containing at 162° C. 3 and 92 per cent. Li respectively. Similarly with potassium the two liquids contain 0 and 95 per cent. Li at 166° C. There appear to be no solid solutions formed in either series. *Lithium-Tin.*—The Li-rich alloys attack glass so strongly that they must be prepared in iron vessels. Lithium lowers the melting-point of tin to a eutectic at 214° C., containing 95 atoms per cent. Sn. In addition three compounds are formed, viz., Li_4Sn at 68° C., Li_3Sn_2 at 465° C., and Li_2Sn_5 by a reaction between the compound Li_3Sn_2 and liquid at 318° C. Li_4Sn is very brittle, and reacts vigorously with water, while the other compounds are only slowly attacked by water. Lithium and cadmium form a continuous series of solid solutions with a maximum at 50 atoms per cent. Cd and 541° C. The alloy containing 67·7 atoms per cent. Cd, corresponding to $LiCd_2$, solidifies at a constant temperature. Apparently two compounds are formed, LiCd and $LiCd_2$. Lithium and Mg form a difficult series to investigate because of the high melting-point of Mg, attack of the protecting tubes being very rapid at these temperatures. Apparently two series of solid solutions are formed, the limits of miscibility in the solid being about 85 and 95 per cent. Mg. In its ability to form compounds with other elements Li is more closely related to Mg than to Na and K, and can be regarded as occupying a position midway between the Na and Mg groups in the periodic table. F. C. A. H. L.

1540. *Copper-Aluminium-Manganese Alloys.* **W. Rosenhain** and **F. C. A. H. Lantsberry.** (Inst. Mech. Engin., Proc. 1. pp. 119–292; Discussion and Communications, pp. 293–339, Jan.–Feb., 1910. Ninth Report to the Alloys Research Committee. Abstracts in Engineering, 89. pp. 125–128, Jan. 28; 157–161, Feb. 4; 187–192, Feb. 11; 223–228, Feb. 18; Discussion, pp. 104–108, Jan. 28, and pp. 286–288, Feb. 25, 1910. Engineer, 109. pp. 103–104, Jan. 28, 1910.)—Contains results of an extended research on the properties and constitution of these ternary alloys. For convenience the alloys are divided into two series: the heavy alloys, rich in Cu, and the light alloys rich in Al. Of the heavy alloys a more complete investigation was only made of those containing over 85 per cent. Cu. The results of the tensile tests on these alloys show that the effect of the addition of Mn in relatively small quantities to alloys of Cu and Al is to raise the yield-point and ultimate strength without reducing the ductility to a corresponding extent; the results of various other mechanical tests on the alloys are also given. Tensile tests at high temperatures show that the strength is well maintained up to about 300° C., but then falls off rapidly: the hope that the addition of Mn would materially improve the Cu-Al alloys in this respect has not been realised. From the dynamic tests carried out it is evident that Mn increases the power of the alloys to resist sudden shock. Abrasion tests made on rings showed some remarkable results, some of the hard alloys losing less than hard tool-steel. The effects of annealing and quenching the alloys at temperatures just above the two critical ranges have been studied. The results of either annealing or quenching the alloys at temperatures near 550° is not very marked. Annealing at temperatures above 800° is found to injure the alloys, while quenching from this temperature produces a relatively hard and brittle material which possesses high tensile strength but very little ductility. Fresh-water and sea-water corrosion tests were carried out on the sand-cast alloys, the specimens being exposed both singly and in contact with mild-steel plates. All the alloys exhibit a very marked resistance to corrosion. A study has been made of the constitution of these ternary alloys containing less that 11 per cent. Al and less than 10 per cent. Mn, and it would appear that these alloys closely resemble the Cu-Al alloys in constitution. In no case does Mn give rise to the formation of a third phase, so that all the alloys consist of either a single solid solution, or of two phases in each of which Mn exists in the form of a solid solution. The compound Cu_3Al appears to be capable of dissolving Mn, and there is no evidence of the formation of a ternary compound. Before dealing with the light ternary alloys a preliminary study of the Al-Mn series was made, the principal result being that a binary eutectic was found to exist close to the Al end of the series, while the alloys on the manganese side of this eutectic contained increasing quantities of the compound Al_3Mn. The existence of this hard, brittle compound at once limits the possible extent to which Mn can be usefully added to the alloys. The study of the light alloys has therefore been confined to the range containing less than 4 per cent. of either Cu or Mn. The mechanical tests on this range of alloys were not very promising, and it was found that the alloys were very sensitive to casting temperatures. The study of the constitution of these alloys shows that there are three distinct phases: A solid solution consisting of nearly pure Al, containing some Cu but practically no Mn; the compound $CuAl_2$; and the compound Al_3Mn. The freezing-point of the ternary eutectic is 522° C. It was ascertained that no thermal changes take place below the point of final solidification, therefore no annealing or quenching experiments were required. An appendix to the paper contains results of experiments on the corrosion of Cu–Al alloys in the sea. The discussion and communications contain a number of points of importance. C. O. B.

1541. *Ternary Alloys of Copper, Antimony, and Bismuth.* **N. Parravano and E. Viviani.** (Accad. Lincei, Atti, 19. pp. 69–75, July 17, 1910.)—The binary system Cu_3Sb-Bi is first studied. These components are only miscible within certain limits, and form neither compounds nor solid solutions. Cooling down a fused alloy containing less than 13 per cent. Bi, on reaching about 700° C. it begins to deposit Cu_3Sb, and, as the temperature falls, continues to crystallise out until at 640° the percentage of Bi reaches 18 per cent. At this point the liquid separates into two layers, one containing 87 per cent. Cu_3Sb, and the other 92 per cent. Bi, and the layer rich in Cu_3Sb, continuing to crystallise this out, gradually approximates to the lower layer containing 92 per cent. Bi, the temperature during this change remaining constant. As soon as the fluid alloy all corresponds to 92 per cent. Bi the temperature again falls, and a further separation of Cu_3Sb takes place. Considering now the ternary Cu_3Sb-Sb-Bi, by the addition of Bi to the mixture having composition *a* in the Fig., the melting-point is reduced, and the curve *ab* is obtained. Similarly, addition of Bi to compound *u* reduces the temperature of reaction between Cu_3Sb, and Sb, and the liquid alloy *u*, giving the curve *ub*. From *b* along *bd* separate simultaneously mixed crystals of Cu_3Sb and Sb, and of Sb and Bi, until at *d* there is a binary eutectic between Cu_3Sb and Bi. With the system Cu_3Sb-Cu-Bi, *e*, *g*, *d*, represent the three binary eutectics, and *f* is the ternary eutectic of the system. The ternary system Cu-Sb-Bi is thus divided into the following regions: Bi *dba* Sb, surface of separation of mixed crystals of Sb and Bi; *uba*, surface of separation of Cu_3Sb; *ubd* Cu_3Sb, surface of separation of mixed crystals of Sb and Cu_3Sb; *dfe* Cu_3Sb, surface of separation of mixed crystals of Cu and Cu_3Sb; Cu *efg*, surface of separation of Cu; Bi *gd*, surface of separation of Bi. Along *ab* crystallise together mixed crystals of Sb, Bi, and Cu_3Sb; along *bd* mixed crystals of Sb and Bi, and of Sb and Cu_3Sb; along *ub* mixed crystals of Sb and Cu_3Sb react with the liquid mass to form crystals of Cu_3Sb; along *ef* there are mixed crystals of Cu and Cu_3Sb; along *gf* crystals of Cu and Bi, and along *df* mixed crystals of Cu and Cu_3Sb and crystals of Bi. W. H. Si.



1542. *Cupro-Nickel Steel.* **G. H. Clamer.** (Metal Industry, 2. pp. 271–273, Aug., 1910. Paper read before the Amer. Soc. for Testing Materials, Atlantic City, June–July, 1910. Eng. News, 64, pp. 124–125, Aug. 4, 1910. Mech. Eng. 26. pp. 335–336, Sept. 9, 1910.)—The author briefly reviews the properties of the Fe-Ni and the Fe-Cu alloys. Alloys containing 5 to 20 per cent. Cu are hard, brittle, and red-short, but on addition of 20 to 50 per cent. Ni they become tough, malleable, and ductile. The ternary alloys have a low coefficient of expansion and resist corrosion to a very high degree. The author discusses the possibilities of making the alloys from Monel metal, and directly from Sudbury ores. In reality the Cu acts very much like Ni, resulting in the production of a steel having the same physical properties of Ni-steel at a much lower cost. F. C. A. H. L.

1543. *Gold-Magnesium Alloys.* **G. G. Urasow** and **R. Vogel.** (Zeitschr. Anorg. Chem. 67. 4. pp. 442–447, July 28, 1910.)—The authors have endeavoured to settle the minor points of difference between their respective equilibrium diagrams of this series [see Abstracts Nos. 1781 (1909) and 178 (1910)], by means of further experiments and a written discussion. Further thermal and microscopical work confirms Urasow's view that a compound Au_2Mg_5 is formed at 796° C. by a reaction between the compound $AuMg_3$ and the liquid, but shows that this compound has a limited range of stability, decomposing at 716° C. into $AuMg_2$ and $AuMg_3$. At the gold end of the series the extension of the range of insolubility of Au and AuMg at low temperatures observed microscopically by Vogel, is substantiated. Urasow's curves are to be regarded as more accurate than Vogel's because of the larger number of observations made. F. C. A. H. L.

1544. *Corrosion of Bronzes in Solutions of Electrolytes.* **F. Giolitti** and **O. Ceccarelli.** (Gazzetta Chim. Ital. 39. 2. pp. 557–575, 1909.)—The authors have studied the corrosion of bronzes containing various proportions of tin, and subjected to various methods of cooling, by means of 80 c.cm of N/10 hydrochloric acid containing 2 per cent. of ferric chloride. The losses in weight were determined after 169 and 366 hours, the results being compared with the aid of micrographs. It is found that two bronzes of identical composition, after subjection to different thermal treatment, may exhibit quite different powers of resistance to corroding agents; such differences correspond with structural differences [compare Curry, Abstract No. 1939 (1906)]. Under similar conditions, the simultaneous presence in a bronze of the two α and β solid solutions, and especially of the products of segregation of these, accelerates the corrosive action. With bronzes containing not much more than 7 per cent. of Sn, the velocity of corrosion increases with the proportion of the β-solution present, no matter whether such increased proportion is due to a different composition of the alloy or to different thermal treatment, such as altered velocities of sodification and of subsequent cooling. When the proportions of α and β solutions, and of their segregation products, remain constant, the velocity of corrosion is greater when the differences of concentration of the nuclei and margins of the separate mixed crystals of the two series are greater. As such differences of concentration are observable under the microscope, the degree of resistance of a bronze to corrosion may be determined beforehand by the same means. T. H. P.

1545. *Influence of Heat Treatment on the Hardness of Bronze.* **E. Heyn** and **O. Bauer.** (Königl. Materialprüfungsamt, Mitt. 28. 6. pp. 344–348, 1910.)—It is known that the mechanical properties of bronze are largely dependent on the heat treatment which the material has undergone, such as the rapidity of cooling in the mould, &c. The article records the results of a metallographic examination of 24 different specimens. The investigation was carried out as a result of the manufacturers observing that one set of castings had very different hardness to another set, although both were supposed to be of the same composition. As a matter of fact, the latter was demonstrated by chemical analysis. The determination of hardness was carried out on the Martens' hardness-tester, and showed one set (denoted as "old") to be considerably softer than the other set (denoted as "new"). An examination of the microstructure (illustrated) showed a much coarser grain in the case of the soft specimens than in the hard specimens. A further series of tests showed that by subjecting the hard specimens to an annealing process (½ hour at 900° C., and allowing 1½ hours to cool to 765° C.) they could be reduced to the same properties as the soft specimens. The approximate composition was 93 per cent. Cu and 7 per cent. Sn. The annealing temperatures of this material lie between 1030° and 850° C. C. A. M. S.

1546. *Production of Cementation Steel.* V. *Cementation with highly Compressed Gases.* **F. Giolitti and F. Carnevali.** (Accad. Sci. Torino, Atti, 45. 7. pp. 191–199, 1909–1910.)—The authors have made further experiments on the cementation of mild steel containing in percentages 0·14 C, 0·8 Mn, 0·08 Si, 0·05 S, and 0·02 P. This steel was subjected to the action of CO at various pressures and at a temperature of 1100°. At a pressure of 9·5 kg. per cm.^{2} maintained for 2 hours, the total thickness of the cementation layer is double that at the ordinary pressure. After 7 hours the cementation layers obtained at the ordinary pressure and at a pressure of 6 kg. per cm.^{2} have thicknesses in the ratio 2 : 3, whilst after 1 hour, under a pressure of 15 kg. per cm.^{2}, the layer is 1·5 times as thick as that obtained in 2 hours at the atmospheric pressure. No hypereutectic layer is formed at the ordinary pressure even in 7 hours, whilst such a layer is observed after 1 hour at 15 kg. per cm.^{2} T. H. P.

1547. *Production of Cementation Steel.* VI. *Cementation of Steels with High Carbon-content by means of Gases at Atmospheric and Reduced Pressure.* **F. Giolitti and F. Carnevali.** (Accad. Sci. Torino, Atti, 45. 8. pp. 230–241, 1909–1910.)—Using the method previously employed [Abstract No. 824 (1909)], the authors have examined the carburising action of various gases at different temperatures on two samples of steel containing in percentages (A) 0·18 C, 0·35 Mn, 0·05 Si, 0·07 P, 0·05 S, and (B) 0·94 C, 0·90 Mn, 0·17 Si, 0·04 P, 0·02 S. At 800° cementation is less intense for steel B than for the extra-soft steel, support thus being given to the view that a considerable part is played by the phenomena of diffusion of the carbon owing to differences of concentration among the different portions of the mass of β or γ iron in which it is dissolved. When ethylene or methane is employed at either the ordinary or reduced (600 or 450 mm.) pressure, the hypereutectic zone is considerably deeper in B than in A. At 900°, the second factor in the cementation process—that is, the diffusion of the carburising gas into the metallic mass—begins to play a preponderating part, and this is still more the case when CO is employed [see preceding Abstract]; similar results are obtained with illuminating gas rich in CO, and, to a more marked extent, at a temperature of 1000°. At 1100° the differences in the course of the carburisation, due to the different initial concentrations of the carbon, are more distinct than at lower temperatures. Microphotographs render evident the accumulation of the cementite in the zone contiguous with the superficial eutectic stratum.

T. H. P.

1548. *Cementation* in vacuo *by means of Pure Carbon.* **F. Weyl.** (Metallurgie, 7. pp. 440–456, July 22, 1910.)—A brief review of the methods used and the results obtained by previous workers is given. The author describes the results of seventeen experiments on heating iron with various forms of carbon in a very high vacuum obtained in a specially designed apparatus. The materials, consisting of electrolytic iron, containing 0·09 per cent. carbon and 0·30 per cent. Mn and specially purified sugar-charcoal, Ceylon graphite, kish and diamond chips, were previously freed from gases by heating *in vacuo* to about 1000° C. for five hours. Rectangular sections of the iron (roughly 12-mm. cubes) were then placed in intimate contact with the various forms of carbon and heated for periods up to 100 hours at temperatures ranging from 750° to 1000° C. The amount of cementation was measured by noting the change in weight of the sections and by microscopic examination, the paper being illustrated by 32 micrographs. The results show that pure carbon in intimate contact with iron produces some, though only slight, cementation, and the author agrees with the view that gases play a most important *rôle* as carriers of carbon during the process of cementation.

F. C. A. H. L.

1549. *Strain Disease in Steel.* **G. Charpy.** (Comptes Rendus, 151. pp. 889–892, Aug. 1, 1910.)—In the study of the transformations of steel, a phenomenon similar to that described by Cohen in the case of tin [Abstract No. 750 (1910)] has been observed. The rate of growth of the ferrite grains in a soft steel on annealing at temperatures between 650° and 800° C., is very much augmented by a preliminary straining of the metal. A superficially strained bar shows after annealing a greater development of the grains at the periphery than at the core. Such differences can be easily detected with the naked eye. By a sufficiently prolonged annealing after straining the whole of a bar of metal can be converted into one grain. While the development of the grain does not affect the tensile strength to any great extent the resilience falls rapidly with the grain-growth. Bars which after straining gave good bending tests were so fragile after annealing at 650° C. that they broke on falling to the ground. Any kind of mechanical strain will produce similar results and the phenomenon probably explains many of the mysterious failures of metals, most of which have been subjected to some form of strain. There is no doubt that a preliminary straining rapidly increases the rate of crystallisation on annealing.

F. C. A. H. L.

1550. *Theory of Anisotropic Liquids.* **W. Nernst.** (Zeitschr. Elektrochem. 16. pp. 702–705; Discussion, pp. 705–707, Sept. 1, 1910. Paper read before the Deutsch. Bunsen-Gesell., Giessen, May, 1910.)—In the case of anisotropic liquids (so-called liquid crystals) one may plausibly assume the existence of large molecular complexes which are commensurable with the wave-length of light. In this case there would be an equilibrium between the complex and the normal molecules which normally would alter gradually, not suddenly, with increase in temperature, the normal molecules increasing at the expense of the complex ones. Since, however, the complex molecules would rapidly become smaller with increase in temperature, it is not impossible that within a very small temperature-interval, they would become small compared with the wave-length of light, so that a sudden clearing of the liquid would take place. This clearing would take place at a higher temperature for light of short wave-length than for light of long wave-length, that is, the absorption should vary for light of different wave-lengths. The author has tested this in the case of para-azoxyphenetole and para-azoxyanisole, using a spectral photometer described by Hildebrand [see Abstract No. 1250 (1908)], but could not observe the expected effect. Clearing took place at the same temperature, both with red and with green light. It was observed that the transparency of the cloudy liquid diminishes as the clearing-point is approached, to increase suddenly when that point is reached. The author expresses himself in favour of Bose's explanation [see Abstract No. 1821 (1909)] of the phenomena observed with anisotropic liquids, and points out how it may be made to account for the sudden clearing which takes place when the anisotropic changes to the isotropic liquid. In the *discussion*, **G. Tammann** expressed himself in favour of the emulsion theory (two-phase liquid system), pointing out that the experiments which had hitherto been made to disprove it were not conclusive. **F. Krüger** and the author considered that the clearing which takes place in a magnetic field is not in accordance with the emulsion theory. T. S. P.

1551. *Abnormal Molecular-weights in Fused Liquids.* **O. Sackur.** (Zeitschr. Elektrochem. 16. pp. 649–653; Discussion, pp. 653–654, Aug. 15, 1910. Paper read before the Deutsch. Bunsen-Gesell., Giessen, May, 1910.)—The following values were found for the molecular lowering of the freezing-points of potassium carbonate (m.p. 909°) and sodium carbonate (m.p. 860°) by a series of salts :—

Potassium Carbonate.		Sodium Carbonate.	
K_2CrO_4	86° C.	NaCl	32° C.
KCl	44	Na_2CrO_4	86
Na_2CO_3	60	K_2CO_3	52
NaCl	65	KCl	54
Na_2CrO_4	102	K_2CrO_4	81

The molecular depression produced by manganese dioxide dissolved in potassium carbonate is 44, so that the manganese-compounds can only contain a single atom of this element. The oxidation of the manganese always stops at a ratio $O : MnO = 1{\cdot}6 : 1$ corresponding with a mixture $2MnO + 3MnO_2$ or $2KMnO_4 + 3K_2MnO_4$; the present observations indicate that the cessation of the action is not due to the actual formation of a complex salt of the above formula, but probably to some type of equilibrium. T. M. L.

1552. *Theory of the Determination of Transference Numbers by the Method of Moving Boundaries.* **G. N. Lewis.** (Amer. Chem. Soc., Journ. 32. pp. 862–869, July, 1910.)—It is now generally recognised that the Hittorf transference numbers are subject to correction on account of the fact that water is transferred as well as the electrolyte. It has, however, been supposed that the figures given by the method of moving boundaries are free from this error. It is now pointed out that the agreement between the corrected Hittorf numbers and the moving-boundary figures of Denison and Steele in the case of potassium and sodium chlorides is a matter of accident and that the volume-changes at the electrodes probably affect the position of the boundary. In a typical case it is calculated that there would be a decrease of volume of 1·2 c.cm. at one electrode and of 26·6 c.cm. at the other electrode for each faraday of current. This would increase the transference number of the sodium chloride from 0·614 to 0·627 on the assumption that there was a displacement of the solution amounting to $\frac{1}{2}$(26·6 — 1·2) = 12·7 c.cm. In the case of potassium chloride the decreases of volume would be 8·8 c.cm. and 18·3 c.cm. increasing the transference number of the anion by 0·005 to 0·518. These corrected values 0·627 and 0·513 agree with those found by the analytic method, namely 0·631 and 0·515. It is suggested that experiments of this kind should be carried out with one electrode in a closed tube and one open, in order that the boundary should be influenced by the volume-changes at one electrode only. Another suggestion is that a neutral substance which does not migrate with the current should be added in such a way as to form an additional boundary relatively to which the motion of the other boundaries can be measured. T. M. L.

1553. *Electrolytic Determination of Anions.* **W. Böttger.** (Zeitschr. Elektrochem. 16. pp. 698–701; Discussion, pp. 701–702, Sept. 1, 1910. Paper read before the Deutsch. Bunsen-Gesell., Giessen, May, 1910.)—The author has investigated the reduction of the nitrate anion to ammonia at a copper kathode. A Perkin rotating anode was used, the kathode being a Pt-gauze cylinder which was coppered with a solution of copper sulphate containing 2 c.cm. of 2-N sulphuric acid, using a minimum current of 2 amps. per 75 cm.^{2} of kathode surface; with 3 amps. it was necessary to add 10 c.cm. of sulphuric acid. The reduction of the nitrate to ammonia was carried out with a current of 2 amps., the anode making 250 r.p.m. The ammonia formed was estimated by titrating the excess of acid left in the solution, using ethyl orange or congo red as indicator. It is pointed out that the accuracy of the result is affected by the indicator used, one which requires a higher concentration of hydrion before it indicates giving a higher percentage of nitrogen. The error is balanced by the fact that some Cu is dissolved off the electrode during the process of washing, thus neutralising some of the acid in the electrolyte. It is not necessary to deposit the Cu on the kathode during the reduction of the nitrate [see Abstract No. 1733 (1908)], since the same electrode can be used for five or six estimations in succession, and can be kept under water for two or three days between two estimations. Satisfactory results were not obtained with a dish kathode. T. S. P.

1554. *Electro-deposition of Metals.* **F. M. Perkin** and **W. E. Hughes.** (Faraday Soc., Trans. 6. pp. 14–17; Discussion, p. 18, July, 1910. Elect. Engin. 45. pp. 62–63, Jan. 21, 1910. Abstract.)—The authors describe a rotating kathode employed for rapid electrodeposition of metals. It consists of sheet Pt spun up so as to form a narrow thimble, the upper end being open and having stout Ir-wire fused to it. This electrode, which has an active surface of 16·3 cm., is rapidly rotated within a cylindrical gauze anode. In other cases, particularly when graded potential methods are employed, a spiral anode of Pt is rotated within the gauze cylinder, which then functions as the kathode. In the potential measurements a cylindrical glass funnel with a glass tube sealed in the side is employed for holding the electrode. Ammonium nitrate was found to be satisfactory as a connecting fluid in the potential measurements, but **H. J. S. Sand** pointed out in the *discussion* that on one occasion he had found it to give rise to completely wrong results. T. S. P.

1555. *Conditions which determine the Composition of Electrodeposited Alloys. II. Silver-Copper.* **S. Field.** (Faraday Soc., Trans. 6. pp. 1–8; Discussion, pp. 8–9, July, 1910.)—The author has extended the study of the quantitative composition of electrodeposited alloys [see Abstract No. 188 (1910)] to those of Cu and Ag; for the electrolyte a mixture of the double cyanides was again used. It was found that simultaneous deposition only occurs within very narrow limits. Thus when the metals are in the solution in the proportion of one equivalent of Ag to 34 equivalents of Cu no deposition of Cu occurs under ordinary conditions of current density, but when in the proportion of one equivalent of Ag to 100 equivalents of Cu, simultaneous deposition proceeds more readily. To examine the effect of varying the current density, free cyanide, and temperature, the following conditions were necessary: 1. Large volume of solution and therefore little change of composition during each experiment. (2) Constant addition of silver to maintain a uniform content of that metal. (3) Solution containing not more than 0·4 gm. of Ag per litre. Under such conditions it was found that the percentage of the more positive Cu varies as follows: (1) Percentage of Cu increases with the current density. (2) Percentage of Cu decreases with rise of temperature of solution. (3) Percentage of Cu decreases with addition of free cyanide. Thus the results follow the usual course as previously shown for brass, and the two metals become more widely separated in the presence of potassium cyanide. In no case were the deposits of any value physically, except where the silver very largely predominated. T. S. P.

REFERENCES.

1556. *Action of Radium Salts on Rubies.* **C. Baskerville.** (Science, 30. pp. 853–854, Dec. 10, 1909.)—Referring to the statements of Berthelot and of Bordas [Abstracts Nos. 2109 (1906), 2117 (1907)], the author's own experiments with rubies from Los Angeles gave negative results as regards change in colour as a result of exposure to radium chloride. L. H. W.

1557. *Silicon-Magnesium Alloys.* **P. Lebeau** and **P. Bossuet.** (Rev. de Métallurgie, 6. pp. 272–278, 1909.)—An account of the preparation of alloys of Mg and Si. Only one silicide, Mg_2Si, is formed. L. H. W.

1558. *Discussion of Cupro-Nickel Steels.* **J. A. Mathews.** (Eng. News, 64. pp. 125–126, Aug. 4, 1910.)—The author quotes a number of experiments on the physical and chemical properties of 3·5 per cent. Ni-steels, which show that up to 0·5 per cent. Cu has no deleterious effects on their mechanical strengths. F. C. A. H. L.

1559. *Quasi-association or Molecule-complexes.* **J. D. van der Waals.** (Konink. Akad. Wetensch. Amsterdam, Proc. 13. pp. 107–124, Sept. 1, 1910.)—A theoretical paper.

1560. *The Electrical Theory of Dyeing.* **W. W. Haldane Gee** and **W. Harrison.** (Faraday Soc., Trans. 6. pp. 42–62; Discussion, pp. 62–70, July, 1910.)

1561. *Studies of Osmotic Phenomena.* **W. G. Wilcox.** (Journ. Phys. Chem. 14. pp. 576–595, June, 1910.)—Measurements of the osmotic pressure of solutions of silver nitrate, lithium chloride, and sugar in pyridine gave values amounting to only about $\frac{1}{15}$ of those calculated according to the gas laws. T. M. L.

1562. *Hydrolysis of Ammonium Acetate and Ionisation of Water at High Temperatures.* **A. A. Noyes, Y. Kato,** and **R. B. Sosman.** (Amer. Chem. Soc., Journ. 32. pp. 159–178, Feb., 1910.)